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RENEWAL OF SUBSCRIPTION

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THEORETICAL PHYSICS IN THE UNITED STATES OF AMERICA*

PERHAPS the most important feature of scientific effort in the twentieth century is the simultaneous advance in fundamental sciences on the one hand and in technology on the other. This is particularly noticeable in the United States where despite the fact that technology has had such an impact on the amazing prosperity of the United States and scientific man-power is in constant demand by industry, fundamental research still engages the attention of the most gifted minds which emerge from its universities. As a typical example of this trend towards basic sciences, we shall consider the status of and contributions in theoretical physics in America today.

Physics deals with the study of matter and natural phenomena and such study consists of two parts :

(1) The precise measurement of physical quantities,

(2) Interpretation of such measurements and consequent understanding of natural phenomena.

The first part falls within the domain of the experimenter, the second, of the theoretical physicist. Till the advent of quantum mechanics, the connection between experiment and theory was quite direct, since the description of nature was based on classical concepts. But for a quantum mechanical description of matter. a complex mathematical formalism was introduced ; no longer a 'pictorial' and 'conventional' method possible. Hence the relationship between experimental observation and the theories became more indirect and involved, perhaps even obscure except to those familiar with mathematical theories. On the other hand, the testing of these theories demand such precision in measurement that the experimenter had to devise new and ingenious techniques based on inventive technology and engineering.

The Universities in America realised this distinction quite clearly and soon became centres of fundamental research besides being just 'training grounds' for technical personnel in industry. With the vigour and initiative characteristic of America's growth and expansion, they invited talent from all parts of the world. The unhappy state of Europe during the turbulent period of the World War became a fortuitous circumstance for America's intellectual and scientific advancement—Einstein, Bohr and scores of leaders of scientific thought moved into the new world which was ready to imbibe the spirit and influence of basic research and fundamental science.

By the end of the Second World War, not merely the importance of mathematical sciences as 'tools' for technology, but their significance as an independent discipline necessary for the intellectual vitality and prestige of a nation was well realised. Theoretical physics became 'fashionable' and pure mathematics attained its 'queenly' pre-eminence. The 'competition' between the theorist and experimenter in suggesting 'leads' to the understanding of nature, led to very important theoretical discoveries and advances in experimental techniques. Laboratories supported by governmental aid and the co-operative effort of the Universities poured forth data on fundamental physical phenomena as 'food for theoretical speculation'. Thus the theoretical study and interpretation of such phenomena became an active pursuit and profession and ceased to be just the close preserve of the leisured savant and the profound natural philosopher.

In studying the progress of theoretical physics, it is convenient to classify it into three broad divisions :

(1) Formal and deductive approach to quantum mechanics,

(2) Interpretation of high energy phenomena and elementary particle interactions,

(3) Low energy phenomena and study of nuclear "structure".

1. Deductive Approach

The logical approach to quantum mechanics was initiated by Dirac with his formulation of the theory of the electron. While Heisenberg, Schrodinger and other architects of modern physics built up quantum theory by intuition and physical insight, Dirac was one of the first to make a formal deductive and rigorous formulation.

Encouraged by the successful prediction by Dirac of the positron and anti-particles

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* This article is based on the impressions of the author during the period of his residence (1957-58) as visiting member at the Institute for Advanced Study, Princeton, U.S.A. He has great pleasure in thanking, Professor J. R. Oppenheimer the Director of the Institute, for his warm hospitality and acknowledging the travel grant of the Asia Foundation which enabled him to accept the membership.

in general, in the early forties theoreticians like Fierz, Pauli and Bhabha seriously attempted to "deduce" equations on a postulational basis. Though these attempts did not meet the desired success, they helped to inject more logic and rigour into theoretical physics. In the United States, Schwinger is the most famous exponent of the view originally expressed by Einstein that the axiomatic basis of theoretical physics cannot be extracted from experience but must be freely invented.

The deductive and logical approach naturally attracted the attention of pure mathematicians like Neumann and Weyl at the Institute for Advanced Study. The classic works of Neumann on the logical foundations of quantum mechanics and of Weyl on group theoretic methods are considered as part of the necessary equipment of any theoretical physicist today. But somehow, pure mathematicians did not make any substantial contribution to the content of quantum mechanics, presumably, as has been stressed in an interesting review of Hilbert's life, because of the fundamental difference between a mathematician's insight and a physicist's intuition. However, the abstract approach still holds the minds of many theoretical physicists and systematic attempts are being made to formulate field theory in a rigorous and deductive manner. The work of Nishijima and Wightman in the United States, the recent proofs of dispersion relations by Taylor, Oehme and others at the Institute for Advanced Study are examples of such attempts. Very recently, Heisenberg and Pauli have attempted to explain the mass spectrum of elementary particles by means of a non-linear spinor equation which has been quantised in a revolutionary way by making use of the indefinite metric originally due to Dirac. But it has to be conceded that despite the recognition of the necessity of a deductive approach to quantum mechanics, there is considerably widespread scepticism in the United States whether such approach will 'deliver the goods' in the near future. There seems to be more faith in the opinion of MaxBorn that the art of scientific prophecy can be learnt not so much by reliance on abstract reasoning as by deciphering the secret language of nature from nature's documents, the facts of experience.

2. High Energy Physics

The first major American contribution after the Second World War was in the field of quantum electrodynamics. By 1948, the application of quantum theory to electrodynamics initiated by Dirac two decades earlier reached a stage when theoreticians were faced with fundamental difficulties which needed essentially new methods and they were provided by the outstanding work of Schwinger at Harvard and Bethe, Feynman and Dyson at Cornell.

The quantum electrodynamics based on the classical concept of point charge gave rise to well-known difficulties such as the infinite self energy of the electron and the "ultra-violet catastrophe". Essentially connected with these difficulties are the infinite fluctuations of the charge and current in the case of matter field and the fluctuations in the field strength in the case of electromagnetic field even in the vacuum state. The existence of such fluctuations of charge and current in the vacuum implies that the vacuum acts like a polarisable medium which causes the phenomena of scattering of light by light or by electrostatic field.

Further progress in the subject came with the experimental discovery of the anomalous magnetic moment of electron by Kusch and the shift in the levels of the hydrogen atoms by Lamb and Rutherford, made possible by the war-time development of the electronic and microwave techniques. To understand these electrodynamic effects, it was found necessary to introduce the idea of renormalization of mass and charge. Suitable covariant renormalization techniques were developed by Schwinger, using formal field theoretical methods. Quite independently without any considerations of field theory, Feynman developed a most unconventional approach based on propagation kernels of single particles which was inherently covariant. His graphical representation of quantum mechanical processes, first applied to electrodynamics is now extensively used even in processes involving other elementary particles. The essential equivalence of Feynman's graphical approach and the formalism of Schwinger was established in a fundamental paper by Dyson. "The evolutionary process by which relativistic field theory was escaping from the confusion of its non-relativistic heritage has recently culminated in a new formulation of quantised theory of fields by Schwinger starting from a basic action principle". This also revealed that the connection between spin and statistics stems from invariance requirements.

By 1952, it was felt that quantum electrodynamics had reached a state of comparative completeness and it was not likely that future development will drastically change the results

of electron theory which gave quantum electrodynamics a certain enduring value. "The real significance of the work of the past decade lies in the recognition of the ultimate problems facing electrodynamics, the problems of conceptual consistence and of physical completeness. No final solution can be anticipated until physical science has met the heroic challenge to comprehend the structure of the submicroscopic world that nuclear exploration has revealed". With the development of high energy machines in the post-war era, many phenomena were observed involving the creation of new and strange particles and high energy physics naturally included the study of these new processes like the production of mesons in nucleon-nucleon collisions and recently in electron-nucleon collisions, and the production of strange particles in high energy interactions.

The vast mass of data from the high energy machines from centres like Brookhaven and Berkeley raised a maze of problems as a challenge to the most gifted of theoreticians. The most famous of them all was the θ-τ puzzle—the identity of the masses and life-times of the two types of K-particles with different modes of decay and parity assignments. Dailtz's analysis of this puzzle claimed great attention at the Rochester Conference in 1956 and it is rather exciting to read the discussions after Yang's introductory talk in which Feynman, Yang, Lee, Bloch, Gellman and Marshak participated. It was of course given to Yang and Lee to question boldly the invariance of parity under space reflection in weak interactions and suggest the Cobalt experiment which was performed by Wu *et al.* and which brilliantly confirmed their predictions. Their remarkable paper reveals the new trend which characterises theoretical physics today,—the theoretical physicist having a live contact with experimental results and going so far as to suggest types of experiments to test the theories. More recently Yang and Lee have proved that analysis of the asymmetry in the angular distribution of the τ decay will determine the spin of the Λ° particles.

During the study of weak interactions, the interest in the universal Fermi interaction has been revived to explain all weak interactions such as β-decay, μ^--capture and hyperon decay. Feynman and Gellman have proposed one such theory by extending the two-component formalism to all Fermi particles while Marshak and Sudershan have employed the "chirality" invariance to the same end. For all these theories the exact coupling between Fermi particles is of decisive importance. It looks at present that the vector and axial vector coupling will be preferred rather than the scalar and tensor. Pais and others are investigating the relative parities of the $K\pm$ and K° mesons.

While of course the theory of weak interactions claimed great attention following Lee and Yang's discovery, attempts are also being made to understand the strong interaction of heavy particles. Gellmann has proposed a global symmetry, *i.e.*, a universal pion-coupling between all heavy particles. He envisages a degenerate spectrum for the eight baryons in the presence of the pion-coupling. When the K-particle coupling is switched on, the baryons are split into groups as observed, *i.e.*, charge independent multiplets. Of course, the study of strong and weak interactions are included together in the former deductive approach mentioned before.

Meanwhile, there was another important theoretical development in the field of interactions of elementary particles involving strong coupling. In view of the evident breakdown of the perturbation theoretical approach to the study of interactions involving strong coupling, there was a long-felt need for a radically different method to tackle such problems. Goldberger at Chicago first realised the importance of the study of the analytic properties of S-matrix from general considerations and by the use of complex variable theory and in particular Hilbert's theorem he was led to relations connecting the real part of scattering amplitude to the integral over the imaginary part, the latter being related to the total cross-section. After a number of non-rigorous but intuitive derivations of such relations by Goldberger, Gellman, Salam and others, the dispersion relations for meson scattering by nucleons have been established in a rigorous way by Bogoliubov from U.S.S.R. and Bremmermann and others from U.S.A. The same approach has been employed in the electromagnetic and weak interactions especially by Bogoliubov. Goldberger is currently investigating dispersion relations for π-meson decay. The "dispersion relation" approach has been utilised to study nucleon-nucleon scattering, the electromagnetic structure of nucleons and similar problems by Goldberger, Chew, Nambu and others.

While high energy physics became fashionable consequent on Lee and Yang's discovery, non-relativistic theories at low energies also

demanded considerable attention. Chew and Low's successes in the theory of pion-nucleon interactions exemplify such attempts. They have shown that if one assumes: (1) Pseudo-scalar interaction, (2) Charge independence, (3) Negligible nucleon recoil, and (4) Predominantly P-wave interaction, then the crossing-symmetry, and unitarity of S-matrix are sufficient to establish the remarkable features of nucleon-pion interaction, in particular the resonance. The same method has also been applied for explaining photo-production of pions by utilising the gauge invariance characteristic of electromagnetic interactions.

Drell and others have extended the Chew's theory to include S-wave interaction which is strongly isotopic spin dependent, the nature of which is not fully understood. Chew's theory has also been applied to nucleon-nucleon interaction potential. Assuming only P-wave coupling, Gartenhaus has calculated the nucleon potential upto fourth order in the coupling constant. But this potential is inherently defective in that it does not yield any spin-orbit coupling. Recently, Marshak and Signell have proposed a phenomenological potential which simply consists of Gartenhaus potential *plus* spin—orbit interactions term obtained from phenomenological considerations.

As has been recognised for a long time, the knowledge of nucleon-antinucleon interaction is very essential in explaining the problem of nuclear forces. Attempts have been made to explain the large annihilation cross-section for N-$\bar{N}$. Chew's theory has also been applied to the problem of nuclear forces by Miyazawa from Japan, Klein and Mcormick from U.S. and Novoshilov from U.S.S.R. who have reduced the problem of two nucleon interaction to that of one nucleon. In recent years, the Compton scattering of protons have been re-examined from the point of view of Chew's theory.

3. Low Energy Physics and Nuclear Structure

While in the field of high energy physics we deal with the nature of elementary particles individually and their interactions, the collective properties of nuclear matter and the many-body problem of the nucleus (especially heavy nuclei) depends on data obtained from comparatively low energy phenomena. These theoretical considerations are usually referred to as "problems of nuclear structure"; the aim of which is to derive the nuclear energy levels, nucleon wave functions, imaginary and real potentials associated with the nucleus. In this, theoreticians have been puzzled for a long time by an apparent contradiction, namely, whatever we know about the nuclear forces indicates that these forces are very strong and have a dependence on position, repulsive cores, exchange character and other "peculiar" considerations. On the other hand, the properties of the nuclei at low energies both for bound states and for the interactions of nucleons with nuclei show the remarkable validity of the one-body approximation based on a very smooth potential without large magnitudes and large variation. This is the basis of many models which work so well, *e.g.*, shell model and the optical model. The apparent contradiction led some people like Teller and Johnson to go to an extreme point of view, *viz.*, to give up any connection between the structure of the nucleus and the nuclear forces as observed in nucleon-nucleon interaction. On the other hand, Brueckner and collaborators attempted rather successfully to resolve this contradiction. The essential merit of the outstanding work of Brueckner lies in that "it takes the nuclear forces as they are delivered to us and constructs from this a theory of complex nuclei which gives us as good an approximation as possible in the one-body picture". Further contributions of Goldstein, Tobocman, Watson, Reisenfield may be mentioned in this connection. Professor Bethe is more inclined to the programme of Brueckner than the extreme point of view of Teller and Johnson. The experimental work relating to the optical model, the polarisation of neutrons at low energy and nuclear reactions involving light and heavy nuclei are being provided from various American laboratories. The emphasis of the theoreticians is still being felt in this field as in high energy physics. The contributions of Professor Lee on the theoretical implication of the parity violation in β-interaction followed by that of C. S. Wu on the experimental evidence of non-conservation of parity in β-decay at the Rehovoth Conference clearly indicate the very close connection between the fields of low energy and high energy physics. The discovery of parity non-conservation in weak interaction which originated in the θ-τ puzzle of the high energy phenomena has become very important in β-interactions.

In a wider sense, the study from a fundamental point of view of problems in different fields of physics has clearly demonstrated the

inter-connection between them and the need for frequent exchange of views in conferences like those held annually at Rochester where both the experimenter and the theoretician are able to discuss the problems together. America has taken the lead in the organisation of such conferences, a lead soon followed in Europe, Japan and Russia. The proceedings of such conferences are considered sources as important as publications in scientific journals for future research.

It is the earnest hope of the young scientific community in India that at a time when our country is almost possessed by a desire for technological advancement, enough emphasis should be laid, as has been done in the United States on fundamental sciences as a necessary and independent discipline.

University of Madras, Madras. ALLADI RAMAKRISHNAN.

LIFE OF SATELLITES

ONCE a satellite is put in orbit, how long it will exist is determined by the two factors: (i) the initial period of its revolution which depends only on the major axis of the orbit, and (ii) the resistance or impeding force to its motion. By watching the diminution of the period of revolution we can get a good idea of the change in dimensions of the orbit and the decline in its altitude over the earth's surface.

The satellite moves in an extremely tenuous atmosphere of density not exceeding one four-thousand millionth of the density of air at the earth's surface, and the force of resistance in the lowest part—the perigee—of the orbit is not more than 2 g. per square meter. Even this small impeding force affects the satellite's motion substantially. The maximum height of the orbit—the apogee—diminishes considerably faster than the minimum height—the perigee—and the orbit gradually becomes more and more circular. The impeding force also depends on the "lateral load" or the weight of the satellite per unit area of its surface.

The dependence of the satellite's life on the perigee height can be seen from the following figures which are calculated for orbits which are almost circular. For a perigee height of 1,000 km., the life is practically indefinite; for 500 km. it will live from 2 to 7 years depending on the magnitude of the lateral load; for 160 km., the satellite will make but one revolution only.

The Three Sputniks.—When placed in the orbit, Sputnik I and its carrier rocket had the same perigee heights and same periods of revolution. But because of the difference in the lateral loads, their periods diminished by 1·6 and 2·7 seconds respectively in 24 hr. This accounted for the life of the sputnik being 92 days while that of the carrier rocket was only 58 days. Sputnik II and its carrier rocket had almost the same lateral load as the carrier rocket of Sputnik I. But they revolved round the earth for 161 days. The longer life of Sputnik II was due to the fact that its initial period was 103·7 min. which was 7·5 min. more than that of the carrier rocket of Sputnik I.

Sputnik III had its initial perigee height practically the same as those of the two earlier sputniks. But its initial period was greater, being 106 min. Its lateral load also is greater. Preliminary calculations indicate that Sputnik III will have a life-time of nearly 500 days (1½ years) and its carrier rocket about 6 months. (Y. Morozov in *Soviet News.*)

COBALT-60 USED IN EXPERIMENTS TO CONVERT COAL TO GAS

SCIENTISTS at Columbia University in New York are experimenting with a powerful radiation source to try to convert coal to methane, the major ingredient of natural gas. The source used in this research is a 20-lb. 1,400 curie block of radioactive cobalt-60, one of the biggest pieces of radioactive cobalt available to scientists in the United States.

With it chemists and chemical engineers are studying the effects of radiation on the hydrogenation of coal to methane.

The coal is heated, exposed to high pressures and radiated with the cobalt-60 source. Radiation helps to break up the coal and catalyzes the so-called hydrogenation reaction in which the natural coal is broken down into a gaseous mixture consisting mostly of methane.—*Science Newsletter*, 4573.

ELECTRICAL EFFECTS IN THE INFRARED AND THE NEAR ULTRAVIOLET ABSORPTION SPECTRA OF ORGANIC ISOTHIOCYANATES

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Contribution from the Departments of Chemistry, De Paul University, Chicago, Illinois, U.S.A., and Purdue University, Lafayette, Indiana, U.S.A.

THE important purpose of correlating the frequency shifts and intensity changes in absorption spectra is to get a better understanding as to how different electronic interactions affect any particular absorption band. Consideration of the infrared absorption spectra together with the ultraviolet absorption spectra would, therefore, provide interesting information concerning both the ground and excited states. Since the quantum mechanical calculations of electron distribution around linkages are not sufficiently accurate, it is considered important to study the effect of structural changes on the band positions and intensities of a series of related molecules in the infrared and ultraviolet regions.

As a result of a number of investigations,[1-4] it has been possible to conclude that the wavelength changes in the B-band of the ultraviolet absorption spectra of benzene derivatives are mainly caused by resonance and steric interactions. Consequently, the position of the B-band in the ultraviolet absorption spectra for *para*-disubstituted benzenes appears to be a good measure of the resonance effects. It has also been possible to conclude that the infrared frequency shifts in *meta*- and *para*-disubstituted benzene derivatives are determined by the same factors that decide the chemical reactivity.[5] In this paper we have reported on the electrical effects in the infrared and the near ultraviolet absorption spectra of organic isothiocyanates.

There have been no reports of the ultraviolet absorption spectra of organic isothiocyanates in the literature.[6] We have now studied the near ultraviolet absorption spectra of a number of alkyl and aryl isothiocyanates. Recently, Lieber, Rao and Ramachandran[7] have made extensive studies on the infrared spectra of organic isothiocyanates and have assigned the characteristic isothiocyanate vibration frequency between 2060 and 2105 cm.$^{-1}$ We have now studied the substituent effects on this vibration frequency in *para*-substituted phenyl isothiocyanates.

The ultraviolet absorption spectra were recorded in purified cyclohexane using a Cary recording spectrophotometer and also a Beckman model DU spectrophotometer. The wavelengths (λ_{max}) in mμ and the molar extinction coefficients (ϵ_{max}) corresponding to the absorption maxima are summarized in Table I. The infrared spectra were recorded in carbon tetrachloride solutions using a Perkin Elmer, Model 21, spectrophotometer. The -NCS vibration frequencies are listed in Table I.

TABLE I

Infrared and ultraviolet absorption spectra of organic isothiocyanates (R-NCS)

R	ν, cm.$^{-1}$	λ_{max}	log ϵ_{max}	λ_{max}	log ϵ_{max}
CH_3	.. ..	249	3·34	..	..
C_2H_5	.. ..	249	3·41	..	..
n-C_4H_9	.. ..	249	3·50	..	..
n-C_7H_{15}	.. ..	249	3·50	..	..
C_6H_5	.. 2045	270·5	4·11	281	4·12
4-$CH_3C_6H_4$	.. 2050	272	4·20	283·5	4·19
4-ClC_6H_4	.. 2037	276	4·20	287·5	4·19
4-$CH_3OC_6H_4$	.. 2062	275·5	4·19	286·5	4·16
4-$N(CH_3)_2C_6H_4$	.. 2093	297·5	4·58	310	4·54
4-$CH_3COC_6H_4$*	.. 2022	292	4·37	305	4·40
4-$NO_2C_6H_4$†	.. 2016	312·5	4·24	323	4·15
2-ClC_6H_4	.. ..	276·5	4·09	286	4·08

* This compound has an additional peak around 240 mμ. † This compound also has an additional peak around 250 mμ and the 323 mμ band appears as a shoulder.

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All the *n*-alkyl derivatives show a band at 249 mμ, characteristic of the isothiocyanate group. The intensity of this band appears to increase with the chain-length of the alkyl group. The phenyl derivatives exhibit two absorption bands at wavelengths considerably higher than the alkyl derivatives. The intensities of these bands are also much greater than those of the alkyl derivatives.

The λ_{max} values of the *para*-substituted phenyl isothiocyanates can be correlated with the Taft resonance parameters[8] and the Hammett σ-values[9] of the substituents and they approximately follow Rao's correlations.[3,4] The approximately linear relations seem to hold as long as the *para*-substituent is an electron donating group, indicating that the isothiocyanate group is electron-withdrawing in nature. The large wavelength shifts in the p-acetyl and the p-nitro derivatives are probably due to the absorption of these groups themselves. It is interesting to note that the p-acetyl derivative shows an absorption band around 240 mμ, corresponding to the B-band of acetophenone indicating that there is negligible interaction between the isothiocyanate and the acetyl groups. This is understandable since both the groups are electron-withdrawing in nature.[3,4] The p-nitro derivative similarly shows an absorption band around 250 mμ probably due to the absorption of the nitro group. The intensities of the ultraviolet bands of these phenyl derivatives seem to increase with the electron-contributing power of the *para*-substituent. This is consistent with the general trends proposed by Rao and Silverman.[10] The *ortho*-chloro derivative absorbs at about the same λ_{max} as the *para*-chloro derivative; however, there is considerable decrease in the intensity of the bands. Such intensity changes indicate small steric influence of the ortho-substituent.[11,12]

The isothiocyanate vibration frequencies in the *para*-substituted phenyl derivatives show a nice trend with the reactivities of the groups. The plots of the frequency ν, against Hammett σ or Brown σ^+ values[9,13] are found to be excellently linear. However, the ν–σ^+ plot (*cf.* Fig. 1) seems to show lesser deviations from linearity just as the many other systems investigated earlier by Rao and Silverman.[5] The slope of this plot is about -30. The σ^+ value of the acetyl group was assumed to be about the same as the σ value for the group since the group is *meta*-directing in nature.[14]

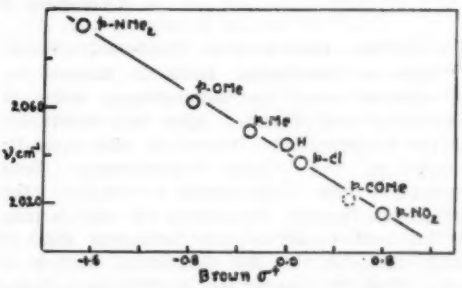

FIG. 1. Correlation of the isothiocyanate vibration frequencies in *para*-substituted phenyl isothiocyanates with the electrophilic substituent constants

The authors' thanks are due to Professor E. Lieber of De Paul University for his interest, and to Mrs. Marge Angell and Mr. W. Baitinger of Purdue University, for their assistance in taking the spectra.

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GEOPHYSICAL EXPLORATION IN THE COASTAL SEDIMENTARY BELT OF MADRAS STATE*

L. N. KAILASAM
Geological Survey of India

AS is well known, the structurally stable mass of Peninsular India is flanked on its eastern coast by sedimentary beds of Cretaceous and Tertiary ages laid down by marine transgressions. There are also sporadic occurrences of Upper Gondwana beds between the Archæans and the Cretaceous-Tertiary formations. A sketch map of this belt, based on the *Geological Map of India* published by the Geological Survey of India (Fig. 1) shows the distribution of the

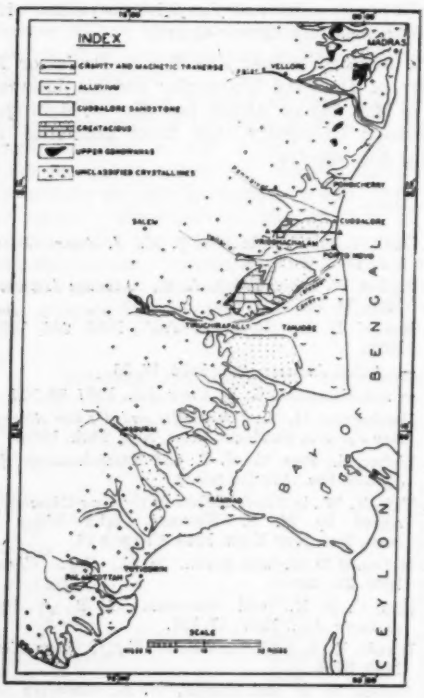


FIG. 1

exposures of these rock formations in the Madras coastal belt.

In the Trichinopoly District, the Cretaceous rocks are underlain by granitic gneisses, but thin beds of Upper Gondwanas also occur occasionally intervening them. They are buried by alluvium in the northern side, while on the eastern side, they are overlain by Cuddalore sandstones of Miocene age. The Cretaceous rocks of this area, as is well known, consist of four stages, *viz.*, (*a*) the Uttattur (lowest) stage comprising sandy clays, calcareous shales and fine silts and occasionally some aranaceous limestones, (*b*) the Trichinopoly stage consisting of sandstones, grits and occasionally shales and shell-limestones, (*c*) the Ariyalur stage which appears more extensively developed and comprises grey to brown argillaceous sandstones, white sandstones and sandy limestones, and (*d*) the Niniyur stage consisting of grey to brown calcareous sands and shales with embedded fragments of flint and chert. The Uttattur beds are presumed to have an average thickness of 1,000 ft. and the Ariyalur beds also have the same order of thickness. As observed on the surface, these beds have a general easterly to north-easterly dip, the average dip of the Uttattur beds being of the order of 10° while that of the Ariyalur beds is of the order of 3 to 5°. All these four stages of the Cretaceous rocks are highly fossiliferous (*vide* Krishnan: *Geology of India and Burma*, 1956).

Exposures of the Cuddalore sandstones of Tertiary (Miocene) age, which lie unconformably over the Cretaceous rocks, extend from Madura in the south to Pondicherry in the north. In view of the fossil evidence observed in what look like Lower Eocene limestones and also in Upper Eocene rocks in the Pondicherry area, an Eocene sequence may also be expected to occur, intervening the Cretaceous and Cuddalore formations. According to recent reports, Eocene limestones have been encountered in deep boreholes sunk for groundwater on the eastern coast, south of Cuddalore town. The Cuddalore sandstones are generally ferruginous and include mottled grits, argillaceous and silicified sandstones and have a gentle seaward dip.

The Upper Gondwana rocks in this area consist of micaceous shales, grey sandstones, and grits. They rest on the Archæan gneisses and are overlain by the marine Cenomanian beds mentioned above. Exposures of the Upper Gondwanas are seen near Uttattur village in

* Published with the kind permission of the Director, Geological Survey of India.

Trichinopoly District and also in small patches near Sivganga in Ramanathapuram District.

The well-known lignite fields of Neyveli and its neighbourhood are located between the towns of Vriddhachalam and Cuddalore and occur within the Cuddalore sandstones. The areal extent of the lignite field proved so far by extensive drilling operations is indicated in Fig. 2. The average thickness of the major lignite seam is between 50 and 60 ft. occurring at a depth of about 180 ft. below the ground surface and no seams have been so far encountered further below up to a depth of 500 ft.

Gravity and magnetic surveys were started by the author in the South Arcot District of this coastal belt towards the end of 1954 as the beginning of a systematic geophysical investigation, by the Geological Survey of India, of the entire coastal sedimentary belt of Madras State. The objectives of these investigations are to determine the thickness of the marine sediments and their structural and stratigraphic disposition with a view to assess the possibilities of occurrence of petroleum in this area and to locate additional major lignite beds, if any exist. As can be readily understood, if a large thickness of these sediments can be proved, the geological interest in this area will be considerably enhanced in so far as the possibilities of finding petroleum are concerned.

The gravity observations were made with a modern portable Worden gravimeter while a Watts vertical force magnetometer was used for the magnetic observations. The Bouguer gravity map of the Vriddachalam-Neyveli-Cuddalore areas is shown in Fig. 2.

The Bouguer anomaly map presents three prominent features, namely (i) a steep fall in the gravity values, with a gradient of 7·5 milligals per mile, in the region of the crystalline border to the west of Vriddachalam town, (ii) a pronounced gravity 'low' in the region of the proved lignite field, and (iii) a steep rise to the east of the Neyveli lignite fields towards the seacoast, with a gradient of 2 to 3 milligals per mile. A gravity 'high' of more than 45 milligals is indicated in the Porto Novo area on the seacoast.

The steep fall in the Bouguer gravity values in the neighbourhood of the crystalline-sedimentary boundary, as indicated in Figs. 2 and 3, has the typical appearance of the anomaly arising from a near-vertical fault. This steep fall in the Bouguer values obviously includes the regional anomalies also, but an examination of the gravity profile along the traverse as shown in Fig. 3 clearly shows that the major part of this anomaly is due to a localised, buried geologic feature, such as a fault Assuming safely a local anomaly of 25 milligals, the downthrow of this fault would be of the order of 3,200 ft. assuming a density

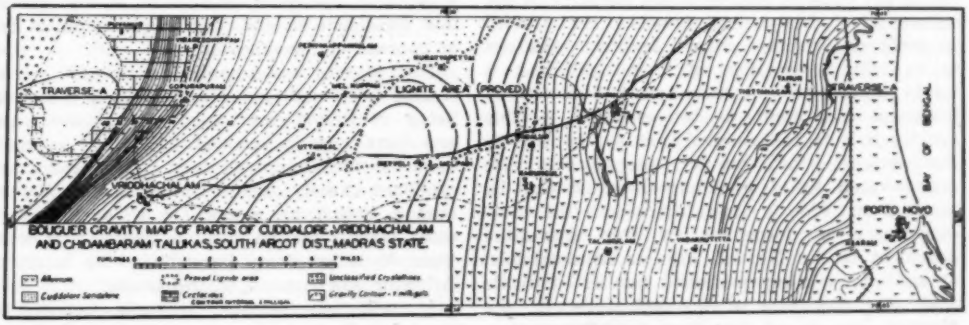


FIG. 2

The observations were started in the Cuddalore-Vriddachalam belt, in view of the special interest afforded by the lignite fields of Neyveli and neighbourhood, inasmuch as the presence of the lignite has an important bearing on the gravity observations due to the marked contrast in density between the lignite and the enclosing Cuddalore sandstones,

contrast of 0·6 between the crystalline and sedimentary rocks. The downthrow would be of the order of 4,000 if the density contrast is assumed to be 0·5. Also, the faulting would be down through the crystallines, because the density contrast between the Cretaceous and Tertiary rocks is not large enough to cause such a large gravity anomaly.

Alternatively, however, this gravity anomaly can also be explained by pronounced downwarping, with a steep gradient, of the crystalline basement.

imposed on the strong isostatic regionals, causing distortions in the isogams. A pronounced gravity 'high' is indicated to the south of Porto Novo. While this gravity 'high'

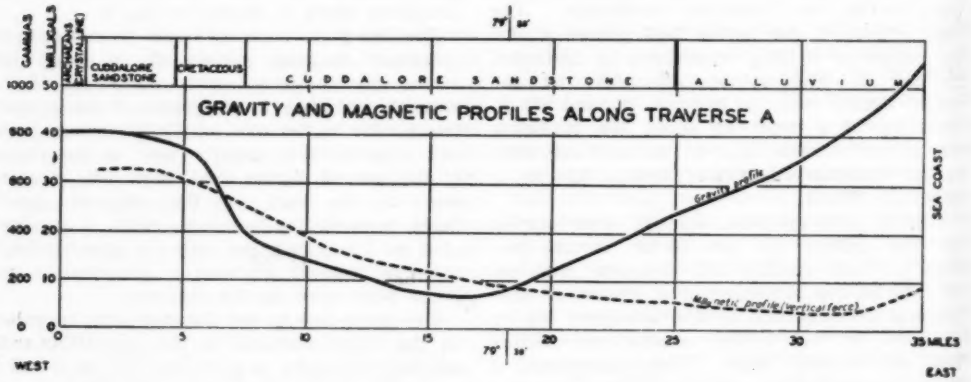


FIG. 3

The second pronounced feature, namely the gravity 'low' in the lignite area to the north of Neyveli, with a fall of more than 35 milligals relative to the values over the crystallines in the west and with a fall of more than 45 milligals relative to the gravity values over the seacoast can be explained, on the basis of rigorous quantitative interpretations only as due to a deepening of the crystalline basement and is not to be attributed to the presence of the lignite which has a low density. The gravity anomaly due to the proved lignite works out to be only a fraction of a milligal and a solid lignite bed of more than 3,000 ft. in thickness will have to be assumed if this gravity low is to be attributed to the lignite. Furthermore, the gravity anomaly is also corroborated by a magnetic 'low' as can be seen from Fig. 3, and, therefore, the evidence for a deepening of the crystalline basement in the Neyveli area is unmistakable. Quantitative interpretations further indicate that the thickness of the sediments in the Neyveli area is not less than 5,000 ft.

East of Neyveli, there is a sudden reversal in the trend of the gravity variations, the gravity values rising steadily, with a steep gradient of 2 to 3 milligals per mile, towards the seacoast. The isogams in this part of the area have the appearance of a typically large isostatic anomaly. A close examination of the isogams in the coastal area (Fig. 2) shows that there are also local anomalies super-

may be interpreted as indicating the possible rising of the crystalline basement towards the seacoast, it has to be pointed out that the magnetic values, on the other hand, continue their downward trend east of Neyveli with an inappreciable rise on the seacoast which can be readily explained as due to the presence of the coastal sands. A quantitative interpretation of the magnetic anomaly indicates a depth of the order of 8,000 ft. to the crystalline basement in the Tirttanagiri area, a few miles west of the seacoast.

The gravity and magnetic surveys in the coastal sedimentary belt of Madras State are being continued southward along the coast and have now progressed up to the northern bank of the Coleroon river. The pronounced synclinal gravity feature noted in the Neyveli area is found to extend in a north-east to south-west direction over a distance of more than 40 miles from Panruti in the north to Ariyalur and beyond in the south.

A reflection seismic traverse across the coastal belt from the crystalline outcrops on the west to Porto Novo on the east, along the Vriddhachalam-Bhuvanagiri-Porto Novo road is now in progress. The seismic results have confirmed the results of the gravity and magnetic surveys as regards the thickness of the sediments. In the coastal areas, between Bhuvanagiri and Porto Novo, the seismic data indicate an order of thickness of 9,000 ft. for the sediments.

In view of the fairly large thickness of sediments indicated by the Geophysical surveys and the presence of Eocene rocks in the area, the prospect of finding oil in this coastal region of Madras State should now be considered as good.

As the terrain is quite favourable for gravity work, exploration for additional lignite beds in other areas of this coastal tract is quite feasible.

The surveys are in progress and further details will be published in due course.

The author acknowledges his gratitude to all his colleagues who have participated and assisted him in these surveys.

1. Kailasam, L. N., *A Preliminary Report on the Gravity and Magnetic Surveys in the South Arcot District, Madras State*, Unpublished Report of the Geological Survey of India, 1956.

SOVIET EDUCATION FOR SCIENCE AND TECHNOLOGY*

THE book consists of twelve chapters, fifteen appendices and a selected bibliography on the Soviet Educational system. The first eleven chapters may be regarded as summarising, at least in the bulk, very carefully collected factual information regarding the Ten-Year School, the Engineering Technicums, the Higher Education and the Graduate and Research Training as they exist now in the Soviet Union. Sample curricula taken from an Engineering School for Mechanical Engineering, from a University for Physics and a Pedagogical Institute for Mathematics are given in an extensive manner. Important educational problems such as those that relate to Selection, Enrolment, Teachers, Text-Books, Grading, Placement and Facilities are discussed in great detail.

In the final chapter, which is the most important one in the reviewer's opinion, comments and reflections by the author are given. The book is truly "a comprehensive survey of Soviet Education with special emphasis on science and technology" written after much thought and study in the belief that "an examination of the educational process within a given society can provide important clues to an understanding of the moral and intellectual climate in which its people live". The author claims that much of the material that has been examined is equally applicable to the entire range of formal training—if not to education in the broadest sense of the term—in the Soviet Union. This claim is all the more important and significant since the title of the book implies and the data within the book bear out the implication that the detailed figures presented and the conclusions drawn therefrom are more directly related to those aspects of Soviet Education which deal with the training of Engineers and Scientists only. At that stage one naturally asks the question whether by examining the processes that dominate particular aspects of education in a country, specially of technical education, one is justified in drawing conclusions in regard to the philosophy and motivations behind the entire educational policy of that country. Policies in regard to technical education are naturally shaped by the transient needs of a country but the programmes in regard to general education have a wider meaning and deeper roots.

More than any other country in the world, the U.S.A. today realises the urgent necessity for examining critically and with reference to lasting values, if possible, the Soviet Educational system. Other countries are equally interested in this vital question. Although the author often analyses the issues against the background of the American Educational system, with a view to present 'Soviet data against a familiar background' as he puts it, he has done valuable service in discussing these issues because the setting up of adequate criteria for judging an educational system is a problem that should interest not one nation or a group of nations but should very well be the concern of mankind as a whole.

In writing the following paragraph,

> "Have the measures so actively fostered and supported by the Soviet Government in behalf of science and technology been measures to develop education or to develop training? Indeed, when we talk about the vast Soviet efforts in schools, colleges, and universities, are we talking about education as we Americans and the other free peoples conceive of education? Or are we talking about training, a far narrower concept? And what, then, emerges when we set the Soviet educational system against our own and attempt the inevitable comparisons?"

* *Soviet Education for Science and Technology*. By Alexander G. Korol. (Published jointly by the Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc., New York, Chapman and Hall, Ltd., London), 1958. Pp. xiv+513. Price $ 8·50.

the author has sought to make a distinction between "education" and "training" and is no doubt partly justified in doing so. The justification is particularly defensible if it is assumed that "the task of American education is infinitely greater, more difficult, and more challenging than that of Soviet education". The tasks of education are, however, universal in character and cannot be very different at different times or in different longitudes. As the author himself accepts, there is, however, no doubt that Soviet education has achieved impressive gains in the quality and quantity of training and to shut one's eyes to these facts is, to say the least, to be under the illusion of self-complacency. The Soviet system has no doubt implanted into its country's educational machinery certain major strengths as well as major weaknesses but the results achieved do call forth a serious study by all concerned. Mr. Alexander G. Korol has succeeded in outlining the problem in a very thorough and painstaking manner and has included in his book a vast amount of statistical data and carefully collected material, making it an indispensable reading for those who wish to get a picture of education in the Soviet Union.

Bangalore-3, S. BHAGAVANTAM.
November 23, 1958.

SYMPOSIUM ON CHEMOTHERAPY IN BACTERIAL AND VIRAL INFECTIONS

A THREE-DAY SYMPOSIUM on the above subject was held under the auspices of the C.S.I.R. on the 2nd, 3rd and 4th November at the Central Drug Research Institute, Lucknow. The Symposium was inaugurated by Prof. M. S. Thacker who also laid the foundation-stone of the pilot plant building for producing drugs for trials on a larger scale.

There were two popular lectures: one by Dr. V. R. Khanolkar on "The Chemotherapy of Cancer" and the other by Dr. B. Mukerji on "Indian Medicinal Plants in Experimental Tuberculosis".

Dr. V. R. Khanolkar, Col. S. S. Bhatnagar, Dr. Hawkins and Dr. S. S. Bhatia were the sectional Presidents. The papers presented at the Symposium included one on "Plant Antibiotics" by Dr. Chopra which dealt with *Mycobacterium tuberculosis*, "Perspective of Chemotherapy" by Dr. M. L. Dhar and "The Enzyme Approach to Chemotherapy" by Dr. C. R. Krishnamurthy which dealt with the role of permease in bacterial chemotherapy. There was an interesting paper by Drs. Sheth and Krishnamurthy of Bombay, dealing with the spectacular clinical improvement in cases of pulmonary tuberculosis by the use of powdered fruit of Rudanti (*Capparis monii*). It is hoped that the value of this drug will be explored further.

There was a paper by the Bengal Immunity group of workers on the chemotherapy of bacillary dysentery, stressing on the possible role of re-excretion of the drug into intestines contrary to the common view that the drug is not absorbed at all and that the beneficial effect is due to its low absorption.

Of the four papers on viral chemotherapy, the one on the methodology by Dr. V. N. Krishnamurthy of Vaccine Institute, Bangalore, emphasised the advisability of using two or more methods even for primary screening of antiviral drugs as against a single test.

There were a few papers on the fungal and parasitic infections and the paper dealing with the method of testing compounds for filariasis by Dr. Hawkins of London evoked much interest.

The absence of papers on two important aspects of chemotherapy, namely, drug resistance and allergy to antibiotics, was noticeable and this perhaps is significant in the sense that both these problems might not be still acute in our country. The papers, in general, covered much ground eliciting thought-provoking ideas and it should be said that the Symposium was a success.

V. N. K.

U.S. 'ATLAS' MISSILE

THE successful launching of the 'Atlas' missile marks a distinct step forward in space operations. The missile was fired into orbit from the base at Cape Canaveral, Florida. Its weight is 8,700 lb., length 85 ft. and width 10 ft. It has penetrated 928 miles into outer space and the lowest point of the orbit is estimated at 114 miles. Its period round the earth is about 100 minutes. It carries a communications system which has proved successful in receiving messages broadcast from the earth and relaying them back.

EXPLORER IV, FOR INTENSIVE STUDY OF COSMIC RADIATION

THE heaviest American satellite, Explorer IV, launched on 26 July, has a period 110·2 minutes, apogee 1,380 miles and perigee 157 miles. Though of the same size, 80" as Explorers I and III, its weight, 38·43 lb., is heavier by 7 lb. The added weight is in instrumentation. Earlier instruments of previous satellites for temperature and micrometeorite data have been eliminated and the entire payload is devoted to cosmic ray equipment that will provide the most detailed radiation data yet obtained by a U.S. IGY satellite. Included in the instruments are four separate cosmic ray detectors, two radio beacons, one high-power and one low-power, subcarrier oscillators and battery packs.

Of the two GM tubes and two scintillation counters, one of each is shielded to eliminate data below certain energy levels, and the unshielded scintillation counter's data are directed into two radio channels reporting different levels of energy. This gives ground radio stations five channels of information. Thus, it will give not only a wider range of cosmic ray data but will break the information down into levels of intensity. Explorers I and III reported only the gross amount of radiation they encountered, but did not differentiate between the high-energy and low-energy particles. Thus, out of the 20,000 counts per second reported by them in the high altitude portions of their orbits, it was suspected that a small percentage of these counts was due to high energy particles, but it could not be proved.

Now in Explorer IV, the shielded counters will respond only to the high energy particles, while the unshielded counters will "see" everything. Furthermore, the unshielded scintillation counter is provided with special pick-ups which can further differentiate between energy levels.

Both the high-power and low-power radio beacons will transmit continuously for an expected life of two months. The low-power beacon radiates 10 milliwatts energy and will be used mainly for tracking, but it will also report the same data as the high-power transmitter which radiates 30 milliwatts energy.

Thus the data from Explorer IV, when made available will lead to greater precise knowledge in the study of corpuscular radiation in space. (*Science*, 15 August 1958.)

OBITUARY

PROF. W. PAULI

PROFESSOR WOLFGANG PAULI, whose death took place in Zurich, on December 15, 1958, was Professor of Theoretical Physics at Eidgenössische Technische Hochschule, Zurich, since 1928. He was also a member of the Institute for Advanced Study, Princeton, New Jersey, U.S.A., since 1940. He became a naturalized United States citizen in 1946. He was awarded the Nobel Prize in Physics for 1945, for the discovery of the exclusion principle, also called the Pauli principle.

Prof. Pauli was born in Vienna on April 25, 1900. He obtained the Ph.D. from Munich in 1921. Between 1921 and 1928, he was connected with the Universities of Gottingen, Copenhagen and Hamburg. He was a close associate of Prof. Niels Bohr for some time. He also held Visiting Lecturer's post in the Universities of Michigan and Purdue.

The "exclusion principle" for which he was awarded the Nobel Prize was discovered in 1925. "It is to a certain extent supplementary to the quantum theory, but at the same time it occupies an independent position. In its original form, the principle was built on the older quantum theory, which assumed fixed paths for the electrons in the atom. It stated that in every type of orbit determined by a definite combination of quantum numbers there can be only two electrons and that they must have opposite spins. This principle has proved to be of fundamental importance, not merely as an expression of the empirically discovered distribution of the electrons in the atom, but also for the interpretation of a number of other phenomena, such as the electric conductivity of metals and the properties of magnetic substances. It has been amply confirmed by its applications to the comprehensive observation material concerning the radiation of atoms and has become particularly valuable for the interpretation of the properties of atomic nuclei, as well as the primary particles, protons and neutrons, which make up the nucleus. After the formulation of the new quantum mechanics, Pauli's principle has been given a more general form, and its importance has become more and more obvious."

Prof. Pauli occupied a leading position in theoretical physics and made many outstanding contributions on quantum mechanics and nuclear physics. He received many honours and medals and was elected to learned societies. He was an Honorary Fellow of the Indian Academy of Sciences to which he was elected in 1947.

LETTERS TO THE EDITOR

FLUORESCENCE REACTION FOR THE DETECTION OF BORIC ACID*

NEELAKANTAM AND ROW[1] introduced resacetophenone as a reagent for detection of boron and boric acid, by a fluorescence test under filtered u.v. light. This reagent possesses certain unique features—a sulphuric acid solution of it is non-fluorescent under filtered u.v. light but with boric acid it yields a bright blue fluorescence. Its limit of sensitiveness in sulphuric acid solution is one in ten thousand and in aqueous phosphoric acid one in one million according to Feigl's method of calculation. If the final volume is taken into consideration, the sensitiveness is increased ten-fold. None of the common basic radicles interfered; the colour of the metallic ion did not interfere as it was invisible under filtered u.v. light. Nitrate and fluoride interfered considerably. Thiosulphate precipitated sulphur but this did not interfere with the test. Chlorate, chromate and ferricyanide oxidised the reagent producing coloured solutions in which, however, the blue fluorescence was visible. In the case of bromide, bromine was liberated and the latter brought about bromination of the compound which markedly reduced the intensity of fluorescence. With iodide, the separation of iodine rendered observation difficult. Tartrate underwent carbonisation but the consequent difficulty in observation of fluorescence was reduced by diluting the solution with more acid.

The chief drawback of this reagent, however, is the necessity of working under filtered u.v. light in a dark room. It is, therefore, desirable to investigate the effect of substitution of the molecule with a view to produce a reagent which could yield the same effect in daylight itself. A few substituted resacetophenones have been synthesised and examined.[1] Results are reported in Table I.

The results show that 5-amino resacetophenone alone yields a result comparable with that of resacetophenone, under filtered ultraviolet light. However, there is no shift from the ultra-violet to the visible region. It is to be noted that even the 1-acyl-2-naphthols[2] gave the fluorescence effect only under ultraviolet light. A mere increase in molecular weight does not bring about any shift of the fluorescence effect into the visible region.

Dept. of Chemistry, Sri Venkateswara Univ., Tirupati, *July* 23, 1958.

N. APPALA RAJU.
K. NEELAKANTAM.

* This investigation was carried out at Andhra University, Waltair.

1. Neelakantam and Row, *Proc. Ind. Acad. Sci.*, **1942, 16A**, 349.
2. Appala Raju and Neelakantam, *Curr. Sci.*, 1951, **20**, 322.

TABLE I

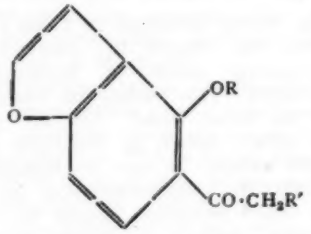
Sl. No.	Reagent	M.P. °C.	Fluorescence			
			Without boric acid		With boric acid	
			Daylight	u.v. light	Daylight	u.v. light
1	4-O-acetyl resacetophenone ..	75–76	Nil	Nil	Nil	Pale blue
2	5-Nitro-resacetophenone ..	142	Nil	Nil	Nil	Nil
3	5-Amino-resacetophenone ..	240–42	Nil	Nil	Nil	Intense bright blue
4	Monobromo-resacetophenone ..	176	Nil	Nil	Pale yellow	Deeper yellow
5	2 : 4-Diacetyl resorcinol ..	85–87	Nil	Nil	Nil	Pale yellow
6	4 : 6-Diacetyl resorcinol ..	180	Nil	Nil	Nil	do.
7	Dinitro-resacetophenone ..	164	Nil	Nil	Nil	Nil

NOR-PONGAMOL FROM PONGAMOL

METHODS[1] of demethylation of pongamol (I) using hydriodic acid or anhydrous aluminium chloride, have led to the formation of either furano (2′ : 3′ : 7 : 8) chromone (II) or a more complex compound and in no case nor-pongamol (III) was obtained. Using magnesium iodide in dry ether solution according to the procedure given below, we have been able to obtain besides the furanochromone, nor-ponga-

mol, whose structure has been established as 5-ω-benzoacetyl-4-hydroxy-benzofuran (III) by two independent methods: (1) a direct synthesis using 5-acetyl-4-hydroxy-benzofuran (V) and passing through 5-acetyl-4-benzoyloxy-benzofuran (IV) and (2) by cyclising it to give (II) whose identity with furano (2′ : 3′ : 7 : 8) flavone was established by comparison with an authentic sample obtained by the demethylation of pongamol using hydriodic acid.

Pongamol (1 g., 1 mol.) dissolved in dry benzene (50 ml.) was treated with magnesium iodide (1 g., 1 mol.) in dry ether (50 ml.) with

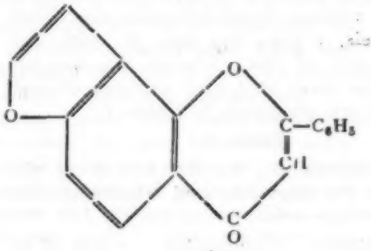


(I, R: CH_3; R′: COC_6H_5)
(III, R: H; R′: COC_6H_5)
(IV, R: COC_6H_5; R′: H)
(V, R: R′: H)

immediate precipitation. The solvents were then removed under suction, temperature then raised to 150° C. during half-hour and maintained at that temperature for another half-hour. The cooled pale brown mass was then decomposed with cold dilute sulphuric acid, filtered and then washed with sodium bisulphite solution. The residue in ether solution was then treated with copper acetate and the copper complex (A) which completely precipitated during half hour [copper complex (A), m.p. 278-80° C. after one crystallisation from dioxan] was separated from the ether solution (B) and decomposed using dilute sulphuric acid. Nor-pongamol was obtained as pale yellow prisms from methanol, m.p. 141-43° C., with an intense purple ferric reaction. (Found: C, 73·0; H, 4·4: $C_{17}H_{12}O_4$ requires C, 72·9 and H, 4·3%.) A mixed melting point with an authentic sample of furano (2′ : 3′ : 7 : 8) flavone is depressed.

Evaporation of the ether solution (B), left a residue, which melted at 146-47° after one sublimation, having no positive ferric reaction. A mixed melting point with an authentic sample of furano (2′ : 3′ : 7 : 8) flavone was undepressed.

Starting from 5-acetyl-4-hydroxy-benzofuran[2] (V), nor-pongamol was synthesised passing through the stage 5-acetyl-4-benzoyloxy-benzofuran (m.p. 100-02° C. d. with previous sintering) using benzoyl chloride and pyridine (Found: C, 73·2; H, 4·6; $C_{17}H_{12}O_4$ requires C, 73·0 and H, 4·3%) which was subsequently subjected to a sodamide migration to give nor-pongamol. By boiling nor-pongamol in glacial acetic acid solution with anhydrous sodium acetate, furano (2′ : 3′ : 7 : 8) flavone was obtained, the identity of which was established by a mixed melting point.



II

C. Bheemasankara Rao.
V. Venkateswarlu.

Dept. of Chemistry,
Andhra University,
Waltair, *June* 26, 1958.

1. Rangaswamy, S. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1942, **15A**, 417; Narayanaswamy, S., Rangaswami S. and Seshadri, T. R., *J.C.S.*, 1954, 1871; Krishnaswamy, B. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1942, **15A**, 437.
2. Bheemasankara Rao, C. and Venkateswarlu, V., *Curr. Sci.*, 1956, **25**, 357.

FURTHER STUDIES ON THE INFLUENCE OF THYROXINE AND TRIIODOTHYRONINE ON THE GROWTH AND METABOLIC PROCESSES IN THE RICE MOTH LARVAE (*CORCYRA CEPHALONICA* ST.)

Thyroxine and its active analogues have recently been shown to have a marked growth-promoting effect when included in the diet of the rice moth larvæ.[1,2] Feeding of thyroid preparations to rats is known to be accompanied by weight loss, and supplementation of vitamin B_{12} to the diet has been shown to afford

protection against such a loss in weight.[3–5] Further, administration of thyroid preparations to rats is known to profoundly influence the activity of several enzyme systems.[6] In the present investigation it has been shown that vitamin B_{12} counteracts the growth-promoting activity of thyroxine and triiodothyronine and that feeding thyroxine, triiodothyronine and thyroxamine to rice moth larvæ results in a decrease in the activity of the enzymes catalase and amylase.

The experimental technique adopted was essentially the same as described earlier.[2] Thyroxine was added at a level of 2·0 μg. per gm. of diet, whereas triiodothyronine was added at two levels, 0·2 μg. per gm. of diet and 2·0 μg. per gm. of diet. Vitamin B_{12} was included at the level of 1·0 μg. per gm. of diet. The results are presented in Table I.

TABLE I

Effect of Vitamin B_{12} on the growth of rice moth larvæ fed thyroxine and triiodothyronine

Concentration of thyroxine or triiodothyronine (μg./gm. diet)	Concentration of vitamin B_{12} (μg./gm. of diet)	Weight of 10 larvæ at the end of 20 days (growth mg.)
..	..	200
0·0	0·5	228
0·0	1·0	233
2·0 thyroxine	..	327
2·0 ,,	1·0	167
0·2 triiodothyronine	..	365
0·2 ,,	1·0	244
2·0 ,,	..	284
2·0 ,,	1·0	228

For studying the influence of thyroxine, triiodothyronine or thyroxamine on the level of catalase, 50 mg. of the larvæ at the end of the experimental feeding period of 15 days, were finely ground in 50 ml. of M/15 phosphate buffer (pH 7·0), whereas for amylase, 50 mg. of larvæ were ground in 5 ml. of M/15 phosphate buffer (pH 7·2). The catalase assay consisted in adding appropriate volumes of enzyme extract to 5 ml. of 0·05 M hydrogen peroxide at definite time intervals. The reaction was stopped exactly at the end of the 5th minute by the addition of 5 ml. of 2 N sulphuric acid. The residuary hydrogen peroxide was titrated against N/200 potassium permanganate. Each sample was assayed in quadruplicates and appropriate blanks were included. Amylase activity was determined according to the method of Smith and Roe.[7] The results of this investigation are presented in Table II.

From the results presented in Table I it can be observed that vitamin B_{12} counteracts the growth-promoting action of thyroxine and triiodothyronine. The feeding of vitamin B_{12} alone at the levels tested, has no growth-inhibitory effect, rather, it stimulates growth to a slight extent. It can be recalled here that vitamin B_{12} supplementation has been shown to afford protection against the toxicity of thyroxine feeding in higher animals.[3–5] The results of the present experiment thus suggest the possibility of a direct antagonism existing between the action of vitamin B_{12} and thyroid hormone. Thyroxine in very small amounts has been used to improve the growth rate of young chicks[8] and it is also known to have a stimulatory effect on the growth of young immature rats. It may be of interest to study the effect of vitamin B_{12} in such of these cases where thyroid feeding stimulates growth. The data presented in Table II make it clear that the activities of both catalase and amylase are appreciably decreased in the thyroid hormone-supplemented group. In mammals, thyroxine administration has been observed to diminish catalase[9] and amylase activities.[10–12] It is evident from this, that *Corcyra* reacts to thyroxine supplementation in a manner similar to higher

TABLE II

Influence of thyroid hormone supplementation on the catalase and amylase activity of Corcyra

Supplement added	Amount added μg./gm. diet	Catalase units*	% Deviation from control	Amylase units†	% Deviation from control
Control ..	No supplement	564·5	..	1100	..
Thyroxine ..	2·0	264·6	−53	692	−37
Triiodothyronine ..	0·1	271·0	−48	803	−27
Thyroxamine ..	3·0	260·0	−54	589	−46

* Catalase unit: ml. of N/100 potassium permanganate consumed per gm. of tissue per minute.

† Amylase unit (Smith and Roe): mg. of starch hydrolysed by 1 gm. of tissue in 30 minutes.

animals. Hitherto, in higher animals it has not been possible to show beyond doubt whether the changes in activities of many enzyme systems observed in thyrotoxicosis are all due to a direct action of thyroid hormone, or are due to a generalised influence on body processes following an imbalance of the entire endocrine set-up. The similarity of *Corcyra* to mammals in reacting in the same way to thyroxine administration can thus be made use of in studying the specificity of the action of thyroid hormone on enzyme systems common to *Corcyra* and mammals. This is specially significant when it is pointed out that in investigations with an organism like *Corcyra* interference due to other vertebrate endocrine secretions can be eliminated.

Triiodothyronine, though supplemented at a very low concentration when compared with thyroxine, produces about the same decrease in enzyme activities. The fact that throxamine is as powerful as thyroxine in decreasing the enzyme activities of *Corcyra* lends further support to the suggestion[2,13] that lower organisms are unable to differentiate any slight change in the alanine side chain of thyroxine moiety.

The authors wish to thank Hoffman-la-Roche Ltd., Basle, Switzerland, for the sample of thyroxamine used in this investigation.

University Biochem. Lab., Madras-25, *July* 8, 1958.

N. R. MOUDGAL.
E. RAGHUPATHY.
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THE CONDENSING ENZYME IN GARCENIA LEAVES (*XANTHOCHYMUS GUTTIFERAE*)

THE widespread presence of the condensing enzyme in animal tissues has been adequately demonstrated.[1] While its presence in yeast, bacteria and moulds has been detected,[2,3] few investigations have been reported about its occurrence in plant tissues. As citric acid is known to accumulate in several plant tissues like Garcenia (*Xanthochymus guttiferæ*), it becomes of interest to investigate the occurrence or otherwise of the condensing enzyme in such tissues. The present note reports the occurrence of the condensing enzyme in Garcenia leaves.

Garcenia leaves were kept under ice immediately on removal from the tree and all subsequent operations carried out at 0° C. The central nerves of the leaves were removed (leaves in which the latex oozed out were discarded as the latex was found to inhibit the enzyme) and the remaining parts were cut into very thin pieces and ground in a chilled mortar for 15 minutes at 0° C. with one-third the weight of alumina and twice the volume of 0·02 M phosphate buffer, pH 7·2. The extract was separated from the debris by centrifugation for 15 minutes at 12,000 r.p.m. and at 0° C. Ammonium sulphate precipitation and gel adsorption techniques were used to obtain a highly purified fraction. This fraction was used for the experiment.

Ammonium sulphate fraction of an extract of *E. coli*, N.R.C. 428, prepared according to the method of Ramakrishnan and Martin,[3] was used as a source of transacetylase.

Citric acid was determined quantitatively by the method of Saffran and Denstedt.[4] Qualitative identification of the acid was made by the paper chromatographic technique described by Varma and Ramakrishnan.[5]

One millilitre of the complete system for condensing enzyme assay contained 10 μM of phosphate buffer, pH 7; 8 μM of $MgCl_2$; 12 units of CoA,* 10 μM of cysteine hydrochloride; 8 μM of dilithium acetyl phosphate, 0·04 ml. of transacetylase preparation (9 mg./ml.), 20 μM of OAA, enzyme preparation and water to make the final volume to 1 millilitre. The temperature of incubation was 30° C. This is essentially the same system as was used by Ochoa, Stern and Schneider.[6]

The enzyme preparation readily catalysed the synthesis of citrate from acetyl phosphate, CoA,

* CoA, Coenzyme A; OAA, Oxalacetate; CSH, Cysteine hydrochloride; Ac-P, Acetyl phosphate.

and oxalacetate in presence of a source of trans-acetylase.

The authors express their thanks to the Head of the Botany Department, Baroda University, for having allowed them to use the leaves from the Botany Garden, and to Miss Mary Clemens, Division of Applied Biology, National Research Council of Canada, for the gift of lyophilised *E. coli*. One of the authors (W. M. D.) acknowledges the receipt of a Research Training Scholarship from the Ministry of Education, Government of India.

Biochemistry Dept., W. M. DESHPANDE.
Baroda University, C. V. RAMAKRISHNAN.
Baroda, India, *July* 21, 1958.

TABLE I

Citrate synthesising system in leaves of Xanthochymus guttiferæ *requirements for enzyme activity**

	Complete system	Deletion from complete system							
		Phosphate	$MgCl_2$	CoA	CSH	Ac-P	OAA	Enzyme	Trans-acetylase
μM Citrate formed	·11	·08	·05	·02	·02	0·0	0·0	0·0	·04

* The system was incubated for 40 minutes at 30° C.

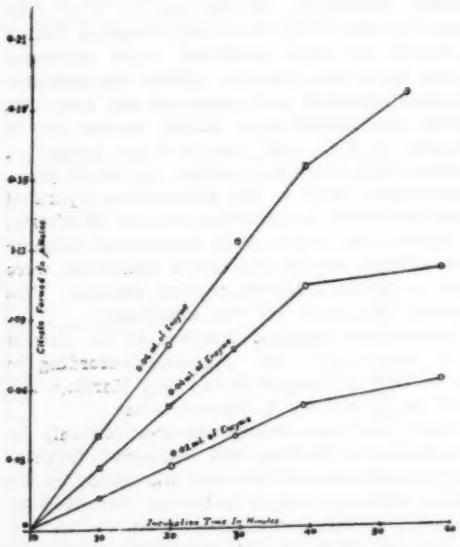

FIG. 1. Effect of enzyme concentration and period of incubation on condensing enzyme.

Fig. 1 illustrates the dependence of citrate synthesis on enzyme concentration and time of incubation.

The requirement for the various components of the system is shown in Table I.

The data presented demonstrate conclusively the presence of the condensing enzyme in Garcenia leaves. This lends support to the hypothesis that citric acid may be synthesised, at least in part, through the condensation of active acetate and oxalacetate. Details of the purification and characteristics of the condensing enzyme will be published elsewhere.

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DETERMINATION OF BLOOD SUGAR USING 0·02 ml. OF FINGERTIP BLOOD

MILLER AND VAN SLYKE,[1] AND SOMMOGYI[2] reported about the differences in the blood sugar levels in capillary and venous blood. They found that the capillary blood sugar was higher than that of the venous blood.

The present investigation is aimed at developing a suitable micro-method for the determination of blood sugar in fingertip blood and to study the variations in the blood sugar levels in samples under normal and pathological states.

In a series of twenty-five preliminary observations with normal subjects under fasting conditions the fingertip blood sugar was determined using 0·02 ml. of blood obtained from the ring fingers of the left hands by a sharp prick with a triangular needle. The Hagedorn and Jensen's[3] method was utilized for these determinations with suitable modifications as follows:

In each of two centrifuge tubes was taken 1 ml. of 0·45% zinc sulphate and 0·02 ml. of 0·1 N sodium hydroxide solution and mixed; 0·02 ml. of blood drawn directly from a fingerprick into a Hellige micropipette was then blown into one of these tubes, the other tube being kept as a blank. The micropipette was washed twice with the fluid in the tube and both the tubes were kept in a boiling water-bath for 2 min., cooled and centrifuged in an electric centrifuge at 2,000 r.p.m. for 2 min. The supernatant fluids were carefully decanted off into two 50 ml. conical flasks, the precipitates washed twice with 2 c.c. portions of distilled-water, centrifuged and the washings added to the respective conical flasks. Two ml. of a standard potassium ferricyanide solution was now added to each of these

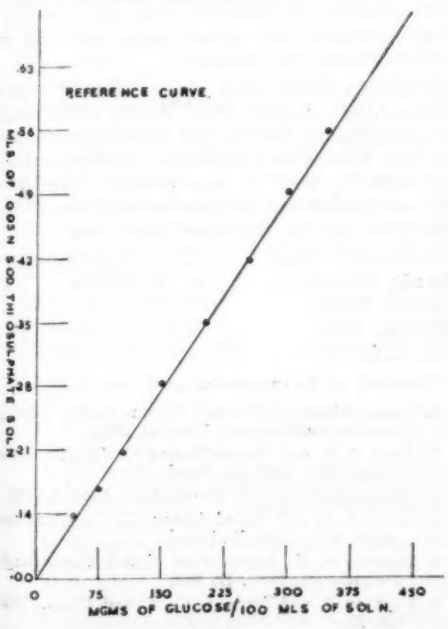

FIG. 1

conical flasks, which were then placed on a boiling water-bath for exactly 10 min. After heating, the flasks were cooled and 3 ml. of an iodine-sulphate solution followed by 2 ml. of 3% acetic acid solution was added to each of these flasks. The solutions were then immediately titrated against 0·005 N sodium thiosulphate solution using starch as the indicator.

The figure representing ml. of thiosulphate required for the blank *minus* ml. required for the blood sample was calculated and the blood sugar value corresponding to this figure was directly read off from the reference curve (Fig. 1) which was previously drawn by using the same reagents and procedures but substituting 0·02 ml. of blood by the same volume of a number of standard glucose (A.R.) solutions of varying concentrations.

The fasting blood sugar values obtained by this method in 25 normal subjects ranged from 102–120 mg./100 c.c. of blood.

Biochem. Lab., Birla College, Pilani, Rajasthan, *June* 9, 1958.

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DETECTION OF ACETYL CoA DEACYLASE IN CITRIC ACID PRODUCING STRAIN OF *ASPERGILLUS NIGER*

INVESTIGATIONS carried out recently in this laboratory on the mechanism of formation of citric acid in *A. niger* led to the observation that, during the early stages of fermentation of this mold no citric acid was formed despite the presence of several citrate synthesising enzymes such as the condensing enzyme, oxalacetic carboxylase, pyruvic oxidase, etc.[1-3] This led the authors to suspect that there might be a formation of C_2 and C_4 acids which, however, might be hydrolysed as soon as they are formed by some powerful hydrolysing enzyme systems thus preventing the formation of sufficient amounts of substrates necessary for the synthesis of citrate. Studies were therefore undertaken in this laboratory to investigate the presence of these hydrolysing enzymes in cell-free extracts of *A. niger* during the early stages of fermentation. The detection of one such enzyme, namely, oxalacetic hydrolase, has already been reported.[4] The presence of another such enzyme, namely, acetyl CoA deacylase, which hydrolyses the active acetate formed, has now been detected.

Aspergillus niger, NCIM 611 was grown in a synthetic medium used by Damodaran, Jagannathan and Kartar Singh.[5] After 72 hr. of incubation, the mold mat was washed well with ice cold 0·02 M phosphate buffer, pH 7·0 and ground in a chilled mortar for 30 min. at 0° C. with equal weight of alumina (Alco A. 301) and four times its volume of 0·02 M phosphate buffer, pH 7·0. The extract was separated from the debris by centrifugation for 15 min. at 12,000 r.p.m. and at 0° C. Ammonium sulphate precipitation and gel adsorption techniques were used to obtain a highly purified fraction. This fraction was tested for acetyl CoA deacylase activity.

1·5 millilitre of the complete assay system contained 100 μM glycine buffer, pH 6·8; 4 μM of $MgCl_2$; 12 units of coenzyme A, 2 μM of cysteine hydrochloride; 8 μM of dilithium acetyl phosphote; 0·1 ml. of transacetylase preparation (9 mg./ml.); 1 μM of sodium fluoride, 0·04 ml. of enzyme preparation and water to make the final volume to 1·5 millilitre. Blanks without CoA and phosphotransacetylase were run. All were incubated for 40 min. at 26° C. and acetyl phosphate left over was determined by the method of Lipmann and Tuttle.[6] Sodium fluoride was used to suppress any phosphatase activity.

Ammonium sulphate fraction of *E. coli*, N.R.C., 428 prepared according to the method of Ramakrishnan and Martin[7] was used as a source of transacetylase.

One unit of enzyme activity is defined as the amount of enzyme required in order to effect the disappearance of 1 μM of acetyl phosphate under experimental conditions.

The enzyme preparation readily catalysed the hydrolysis of acetyl phosphate in presence of CoA and transacetylase.

Fig. 1 illustrates the dependence of acetyl CoA deacylase activity on the enzyme concentration and time of incubation.

Studies carried out on the requirements for the various components of the enzyme system show that acetyl phosphate does not disappear with the omission of deacylase, coenzyme A, transacetylase and acetyl phosphate in the component system whereas its disappearance is less with the omission of sodium fluoride, magnesium chloride and cysteine hydrochloride (0·53 μM* acetyl phosphate disappears in complete system whereas 0·31, 0·12 and 0·42 μM of acetyl phosphate disappear in absence of sodium fluoride, magnesium chloride and cysteine hydrochloride).

The data presented demonstrate conclusively the presence of the acetyl CoA deacylase in cell-free extracts obtained from 3-day-old mat of *A. niger*. The high activity of this enzyme in *A. niger* during early stages of fermentation when no citric acid accumulates and its very

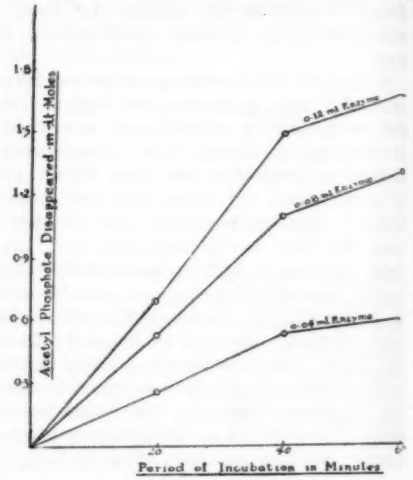

FIG. 1. Effect of enzyme concentration on the activity of acetyl CoA deacylase.

low activity during later stages when citric acid accumulates[8] suggests that, during early stages of fermentation, this enzyme hydrolyses the acetyl CoA formed thus preventing it from combining with C_4 acid to form citrate. Details of the purification and characteristics of acetyl CoA deacylase will be published elsewhere.

Biochemistry Dept., Baroda University, Baroda, India, *July* 29, 1958.

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ON THE SUGAR CONSTITUENTS OF PROCERANIN, SAPONIN OF *ALBIZZIA PROCERA* BENTH.

In a recent communication to the Academy of Sciences, Paris,[1] the presence of a new saponin, proceranin, m.p. 156-58°, in *Albizzia procera* Benth. seeds has been reported. The sapogenin obtained by the hydrolysis of this saponin has been characterised as machærinic acid (Δ^{12}-3 β-21 ξ-dihydroxy-18 β-oleanene-28-oic acid) in contrast to the presence of echinocystic acid (16 α-hydroxy oleanolic acid) and oleanolic acid in *Albizzia lebbek* Benth.[2] and echinocystic acid in *Albizzia althelmintica*.[3]

The solution of the sugars obtained after the hydrolysis of the saponin, proceranin, with sulphuric acid was neutralised with freshly precipitated barium carbonate and the neutral filtrate obtained after the removal of barium sulphate was evaporated to dryness in a vacuum oven at 35-40° C. The syrupy residue left over was dissolved in a few drops of water and chromatographed alongside with authentic sugars using Whatman filter-paper No. 1 and butanol : ethanol : water (4 : 1·1 : 1·9),[4] as solvent mixture using the descending technique. The spots were revealed by spraying with p-anisidine phosphate[5] and aniline hydrogen phthalate.[6] It showed the presence of four sugars, *d*-glucose, *d*-arabinose, *d*-xylose and *l*-rhamnose. Similar results were obtained when the acid hydrolysate was passed through a column of Amberlite IRA 400 and paper chromatographed. It may be mentioned that the presence of a large number of different sugars in saponin of this class (triterpenic) is not rare (*cf. Randia dumetorum*[7] and *Albizzia lebbek* Benth.[8]).

Dept. of Chemistry, Muslim University, Aligarh, *June* 25, 1958.

M. O. Farooq.
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EFFECT OF HUMUS OF LEGUME AND NON-LEGUME ORIGIN ON THE NITROGEN FIXATION IN *AZOTOBACTER CHROOCOCCUM*

Humus is known to have remarkable stimulatory effect on microbiological activities in soil.[1-4] Recently an investigation was carried out to see if difference in the origin of soil humus affected nitrogen fixation by *Azotobacter chroococcum* differently.

Two lb. of Delhi soil sieved through a 2 mm. sieve were mixed with 5% of its weight of the dried and pulverised leaves and stems of the respective plants under study. The latter included three legumes, guar (*Cyamopsis psoralioides*), dhaincha (*Sesbania aculeata*), sunnhemp (*Crotolaria juncea*), and two cereals, maize (*Zea mays*) and paddy (*Oryza sativa*). After making up the moisture to one-third the saturation capacity, the soils were maintained in pots at room temperature, for two months for decomposition of the plant material in the soil and formation of humus. At the end of this period, the soils were taken out from the pots, air-dried and the humus isolated by the method of Sprengel.[6] The humus so obtained was suspended in water and made upto a suitable volume. The concentration of the humus in the suspensions and the nitrogen and the carbon content of suitable aliquots were determined. Seventeen mg. of the humus were added to 100 ml. of Fred and Waksman's medium[5] and inoculated with a strain of *Azotobacter chroococcum*, isolated from Delhi soil. The amount of nitrogen fixed by the organism after incubation of 21 days at 32·5° C. was determined by Kjeldahl's method.

The composition of the humus obtained from decomposition of different plant materials in Delhi soil is given in Table I and the relative

Table I

Composition of humus from different plant materials

(Constituents expressed as per cent. on moisture-free basis)

Material		C	N	C/N
Soil humus (from untreated soil)		57·00	8·70	6·55
Guar humus	..	57·62	5·47	10·47
Dhaincha humus	..	58·09	6·24	9·31
Sunnhemp do.	..	58·14	7·16	8·12
Maize do.	..	58·09	8·53	6·81
Paddy do.	..	58·02	5·18	11·20

amounts of nitrogen fixed by *Azotobacter chroococcum* with humus of different origin are given in Table II.

TABLE II

Effect of humus of different origin on nitrogen fixation by Azotobacter chroococcum

(Each N-figure is an average of 3 determinations)

Material	Nitrogen fixed (mg./gm. mannite)
Control (set without humus) ..	6·23
Soil humus ..	7·73
Guar humus ..	10·90
Dhaincha humus ..	8·37
Sunnhemp do. ..	8·93
Maize do. ..	7·70
Paddy do. ..	7·87

Significant at 1 per cent.
C.D. at 1 per cent. = 0·23.
Guar Sunnhemp Dhaincha *Paddy Maize Soil* Control.

It may be observed from the data in Table I that both humus from guar and paddy had lower contents of nitrogen but higher C/N ratios than the humus from other plant materials.

However, the amount of nitrogen fixation by *Azotobacter* in culture solutions was highest with humus from guar. This was followed by the sets treated with humus from sunnhemp and dhaincha. Humus from the cereals, maize and paddy accelerated nitrogen fixation by *Azotobacter* only to the extent accomplished by humus from untreated soil, as compared to control (set without humus). The different amounts of nitrogen fixed could not be correlated with the carbon or nitrogen values or their ratios.

The author's thanks are due to Dr. B. P. Pal, Director, I.A.R.I., New Delhi, for permission to publish this note, and to Dr. R. V. Tamhane for encouragement during the course of this work.

Indian Agric. Res. Inst., V. ISWARAN.
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GRANITE-PAKHAL RELATIONSHIP (YELLANDLAPAD AREA)

THE Pakhal rocks occupy considerable areas in parts of Khammam and Warangal Districts of Andhra Pradesh (Toposheets No. 65 C/NW and 65 C/NE) and they consist of quartzitic sandstones, clayslates and limestones. Around the Yellandlapad region they are further metamorphosed to quartzites, phyllites, schists and marbles. Their outcrops are separated by 3 granitic bays, *viz.*, the Karepalli, Yellandlapad and Bethampudi bays. From their geological setting, structural features and lithology, William King[1] correlated these rocks with the Cuddapahs. Subsequently they were studied in detail by Mahadevan[2] and Heron.[3] While Mahadevan thinks that Pakhals are really of middle Dharwar age similar to the Gangpur series of Orissa and that the three granitic bays are younger intrusions, Heron is of the view that they should be correlated to the Cuddapahs resting on the Peninsular gneisses, since in their type area and all along to the east of Muner River they do not exhibit any high degree of metamorphism. It is only in the Yellandlapad region that the rocks show intense metamorphism, and the Pakhal-granite relationships are complicated and these are supposed to be due to deep folding, down buckling, migmatisation, remelting and so on.

The author during a course of detailed field examination of the Pakhal-granite relationships in an area of nearly 150 sq. miles found that the rocks are dominantly phyllitic, with subordinate crystalline limestones and quartzites. At places the phyllites have been converted into schists. All the rocks have roughly a NE strike at times changing to a NW or even WNW and have a high southeasterly dip of 60° to 80°.

Studies in the field and laboratory of the so-called granites show that they are more like migmatites with only subordinate granite, thus supporting Read's contention that there is a very close association in the field of metamorphic, migmatitic and granitic rocks (his Plutonic series) and they are very much foliated. Close observation has further revealed that these granites, including the migmatites, are quite possibly highly metamorphosed Pakhal phyllites. At several places, transition can be seen in which the phyllites are altering into schists and these in turn into gneisses. Felspathisation is taking place along the foliation planes of the schists and in some cases felspar ovoids, both pink and

white, are noticed. These are further supported by petrographic studies in the laboratory of nearly 100 microsections.

Large patches of Pakhal xenoliths in the granite mentioned by Mahadevan are merely rocks in which the process of granitization has not been completed. Another important fact that emerged out of these studies is that the foliation direction in the gneisses more or less coincides with the regional strike of the Pakhals. Such remarkable parallelism means two things: either (1) the gneisses have been formed by the granitization of the Pakhals or (2) that any magma that was intruded into the sediments was subjected to the same deforming forces. The indication of a magmatic intrusion is not much in evidence. The granite almost looks like a felspathised Pakhal schist. Even if it is conceded that a granite magma has intruded into the Pakhals, the metamorphism that they have undergone is not thermal metamorphism but regional metamorphism in which both the gneisses and Pakhals suffered similar deformation. This is further supported by petrofabric studies in the laboratory. Petrofabric diagrams prepared in the laboratory for both gneisses and Pakhals suggest that both have undergone same structural deformation suggesting a same tectonic and petrogenitic history for both types. Here again detailed structural studies have thrown some light. The Pakhals of this area have been very much folded into 3 synclines (one of which east of Yellandlapad is an isocline) with connecting anticlines. There appears to be sufficient relationship between metamorphism and depth zones. The presence of uncrystallised banded limestones and slaty phyllites at some places clearly prove that they are in the epizone. Those rocks which were included in the cores of anticlines may be supposed to have suffered greater metamorphism and granitized while in the adjacent synclines they have not passed beyond the phyllite stage. In fact it is by the removal of the anticlinial tops that the granite core has been exposed.

In view of the above field and laboratory evidence, the author agrees with Mahadevan's opinion that the granites of this area are definitely younger than the Pakhals. Whether they resulted from the consolidation of magma or whether they were formed by granitization of the Pakhal rocks is the problem which can be solved only by a detailed field and laboratory investigation which is now under progress.

The author is grateful to Dr. S. Balakrishna, Geology Department, Osmania University, for suggesting the problem and for his helpful discussion and guidance throughout the work.

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Hyderabad, Deccan.
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STERILITY IN GRAM

THE occurrence of sterility in crop plants is a common phenomena and has been reported by several workers in a large number of crops. In case of gram (*Cicer arietinum* L.), Jagannathrao and Subramanyan,[1] earlier reported sterility where the structure corresponding to the ovary was found to contain minute stamen-like organs and some green bodies. They noted segregation of fertile and sterile plants in individual plant progenies of apparently normal plants but did not study the inheritance. During the course of genetical studies in gram at Kanpur, sterility was noted. This paper deals with its morphology and inheritance.

During the studies of the inheritance of a new mutant named Bunchy[2] sterile plants were noted in 1956-57 in an F_3 progeny of a F_2 bunchy mutant type plant. The F_3 progeny bred true for the mutant type character but segregated into fertile and sterile plants. The sterile plants were like the bunchy mutant in all respects except for their smaller leaflet and flower size and lighter foliage colour and more vigorous growth (Figs. 1 and 2). Unlike the sterile mutant reported by Jagannathrao and

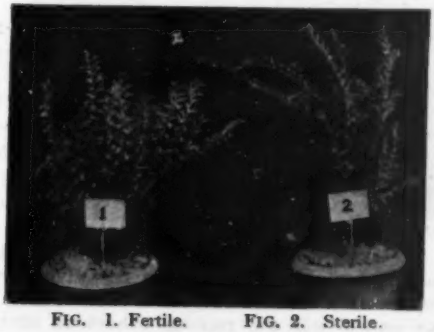

FIG. 1. Fertile. FIG. 2. Sterile.

Subramanyan (1934) where the ovary was replaced by minute stamen-like organs, this

mutant had apparently normal pistillate and staminate parts but it was observed that the anthers did not dehisce properly and less amount of pollen was produced than in the fertile plants. This, however, could not be any cause of sterility as the amount of pollen produced was still enough to give proper seed set. The pollen when studied with acetocarmine stain was found to be quite normal. The meiotic studies also did not reveal any abnormality and the number of chromosomes was found to be $n = 8$ both in case of sterile and fertile plants. More than two hundred reciprocal crosses were made between the sterile and fertile plants but no pod-setting took place. It is, therefore, concluded that there was complete male and female sterility in this case.

During 1956-57, in the F_3 progeny of the F_2 bunchy mutant type plant there were 75 fertile and 29 sterile plants. This gave a good fit to a 3 fertile : 1 sterile ratio as the chi-square value is not significant (Chi-square 0·461 ; P. value between 0·50-0·20). Ten apparently normal fertile plants were selected from this population and their individual plant progenies were grown during 1957-58. The results of segregation are given in Table I.

TABLE I

Breeding behaviour of ten progenies of apparently normal plants selected in 1956-57

Progeny	Segregation		Total No. of plants	Chi-square (3 : 1)	P. value
	Fertile	Sterile			
1	322	102	424	0·201	0·95–0·50
2	110	44	154	1·046	0·50–0·20
3	137	50	187	0·296	0·95–0·50
4	136	49	185	0·217	0·95–0·50
5	178	64	242	0·269	0·95–0·50
6	All	..	183	Breeds true	..
7	150	40	190	1·575	0·50–0·20
8	222	94	316	3·797	0·10–0·05
9	All	..	253	Breeds true	..
10	138	62	200	3·367	0·10–0·05

Of the ten progenies, two bred true for fertility and the remaining eight progenies segregated into fertile and sterile plants and gave a good fit to 3 : 1 ratio (Table I).

These results indicate that sterility in this case is genic and is a simple recessive to the normal fertile condition. As no abnormality in the pollen and the meiotic behaviour of this sterile mutant was observed, embryological studies will now be made. It appears that sterility is due to some incompatibility phenomena.

Govt. Res. Farm, DHARAMPAL SINGH.
Kanpur, *May* 8, 1958. RADHEY SHYAM.

1. Jagannathrao, C. and Subramanyan, P., "A note on the occurrence of sterility in Bengalgram (*C. varietinum* L.)," *Madras Agri. J.*, 1934, **22**, 187.
2. Singh, Dharampal and Radhey Shyam, "Genetics of two new mutants in gram, *Cicer arietinum* L.," *Ind. J. Genet. & Pl. Breeding* (unpublished).

BLIGHT OF SESAME (*SESAMUM ORIENTALE* L.) CAUSED BY *ALTERNARIA SESAMI* (KAWAMURA) N. COMB.

A SEVERE *Alternaria* blight of Sesame or Til (*Sesamum orientale* L.) resulting in defoliation was observed during November-December 1957 in the State Agricultural Research Station, Bhubaneswar. Further survey of the Sesame crop in the cultivators' fields in the district of Ganjam, Puri, Cuttack and Dhenkanal revealed that the disease was widespread and under moist conditions was responsible for considerable damage.

The disease manifests mainly on the leaf blade as brown, round to irregular spots varying from 1 mm. to 8 mm. in diameter. In early stages of infection, minute brown spots appear on the leaf blade which later become darker in colour with concentric zonations demarcated with brown lines inside the spots on the upper surface (Fig. 1). On the undersurface, the spots are greyish brown in colour. In severe infections, several spots coalesce together involving a major portion of the leaf blade and the affected leaves dry and usually drop off.

The fungus was isolated from the infected leaves and the pathogenicity of the fungus was proved.

The fungus is characterized by simple, erect, more or less flexuose, yellowish brown, 0-3-septate conidiophores, arising singly, measuring 30-54 × 4·5-6·5 μ and each bearing conidia singly or in chains at the apex. Conidia are obclavate, yellowish-brown to dark olivaceous brown in colour and measure 30-120 × 9-30 μ (excluding the beak), have 4-12 transverse septa and 0-6 longitudinal septa, at which they are slightly constricted and terminate in a long, hyaline beak 24-210 × 2-3 μ (Fig. 2).

In morphology the fungus closely resembles *Macrosporium sesami* Kawamura (*Fungi, Nippon Fungological Soc.*, 1, No. 2, p. 27, 1931), but differs from it in having some of the conidia occurring in chains. The authors consider that on account of its catenate conidia, the fungus would more properly be placed in *Alternaria*, and *Alternaria sesami* (Kawamura) n. comb. is therefore proposed.

FIG. 1

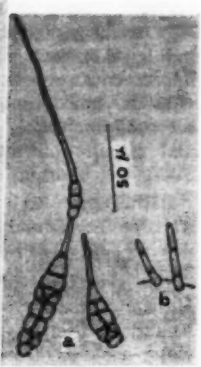

FIG. 2

FIG. 1. Symptoms of the disease on the leaf.
FIG. 2. Camera lucida drawing of conidiophores and conidia of *Alternaria sesami*.
(*a*) Conidia.
(*b*) Conidiophores.

Specimens of the host material with the pathogen have been deposited in the Herbarium of Mycology and Plant Pathology Section, Bhubaneswar, in Herb. Crypt. Ind. Orient. New Delhi (Accession No. 25921) and in Commonwealth Mycological Institute, Kew, England (Herb. I.M.I. No. 71586).

The authors are indebted to the Director and Dr. Ellis of Commonwealth Mycological Institute, England, for having kindly identified the fungus.

Sec. of Mycology & Plant Pathology, N. N. MOHANTY.
B. C. BEHERA.
Utkal Krushi Mahabidyalaya,
Bhubaneswar, *May* 12, 1958.

STUDIES ON VIRUS DISEASES OF PLANTS IN MADHYA PRADESH

I. Green Rosette of *Vinca*

ABOUT 90% plants of *Vinca rosea* L. in the garden of our Department, were observed to show certain abnormal features during January 1955. These plants were characterised by extreme shortening of most of the lateral branches and their sub-branches which bore very much reduced leaves. The lamina in the case of these leaves was thin, soft and glabrous with a uniform green colour. These leaves were situated very near together forming tufts with the result that these shoots had a rosetted appearance as seen in the accompanying figure. The flowers produced by these branches were much smaller than those produced by normal plants. Most of them did not open and none formed fruit. There was, however, no discoloration or distortion of any of the floral parts.

Several attempts made to transmit the disease to young healthy plants of *Vinca* by sap inoculation using carborundum powder as an abrasive, gave negative results. The disease was, however, successfully transmitted by wedge grafting to healthy *Vinca* plants raised from seed and kept under insect-proof conditions. After 4-6 weeks from the date of grafting, typical symptoms of the disease developed in the shoots produced by the stocks. Control plants grafted with healthy scions remained free from the disease during the same period.

FIG. 1

As rosette is a well-known disease of groundnut plants attempts were made to transmit the disease of *Vinca* to healthy groundnut plants by grafting, but they were not successful.

Brooks[1] in the Gambia observed *Vinca* plants showing typical symptoms of groundnut rosette. However, according to Hayes[2] there are three distinct types of rosette disease of groundnuts in the Gambia, transmissible by grafting. These are: (1) Chlorosis Rosette, which is by far the most common and is characterised by chlorotic patches on affected leaves. (2) Green Rosette, so called because no chlorosis occurs and the leaves are darker in colour than in a normal plant. (3) Type No. 3 characterised by thickening of the stem and its curving in a clockwise direction. In the absence of any detailed account of the symptoms it is not known which of the above-mentioned three types of symptoms were observed by Brooks on *Vinca*. Again, no attempt appears to have been made to transmit the symptoms to healthy *Vinca* plants to establish the virus nature of the disease nor to transmit the symptoms to healthy groundnut plants to show that the symptoms observed on *Vinca* were due to groundnut rosette.

The symptoms observed on *Vinca* and described herein are obviously different from Chlorosis Rosette and Type No. 3 described by Hayes as there is no chlorosis of leaves or curving of the stem of the affected plants. They, however, resemble the green rosette of groundnuts to some extent as there is no chlorosis of the leaves which are very much reduced and are in tufts, but they differ from green rosette symptoms on groundnuts in some important respects because in *Vinca* there is no red colouration of the calyx and no thickening of the stem. Again, the disease could not be transmitted by grafting from *Vinca* to healthy groundnut plants. It appears therefore that the disease of *Vinca* under report is distinct from groundnut rosette.

I am grateful to Shri D. W. Kshirsagar, Head of Botany Department, for providing facilities and to Shri S. N. Mishra, then a student of mine, for taking the photograph used here.

Dept. of Botany, R. P. GARGA.
Holkar College, Indore (M.P.),
May 20, 1958.

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THREE NEW BACTERIAL DISEASES OF PLANTS FROM BOMBAY STATE

1. SEEDLING BLIGHT OF ONION

A NEW bacterial disease causing severe tip blight of onion seedlings in Nasik and Broach Districts received in 1953 showed it to be different from the blight, bulb rots and streak so far described. In severe cases, the symptoms extended up to ground level, killing the plants. The technical description of the pathogen herein named *Phytobacterium siccatum* sp. nov. is given below:

Short rods, mostly single, rarely in pairs, $1{\cdot}6 \times 0{\cdot}9\,\mu$; 1-2 polar flagella; gram negative; capsulated; non-spore-former; not acid-fast; colonies on potato dextrose agar plates are circular with entire margin, shining, butyrous, pearly white, measuring 7 mm. in 8 days; similar but heavier growth on yeast-glucose-chalk agar; copious, pale olive Buff* (R) growth on potato cylinders; gelatine and starch not attacked; plain milk neither digested nor peptonised; litmus milk turned alkaline; NH_3 and H_2S from peptone; NO_3 reduced to NO_2; no indol; M.R. and V.P. tests negative; no green fluorescence; in a peptone-free medium, acid without gas from dextrose, lactose, xylose, sucrose, mannitol, glycerol, levulose, dulcitol and salicin; optimum temperature for growth 27-31° C.; thermal death-point 61° C.

Pathogenic to *Allium sativum* L. and *A. cepa* L. Found at Broach and Nasik.

2. LEAF-SPOT OF *Martynia diandra* GLOX.

The symptoms of a new bacterial disease on *Martynia diandra* received from Nasik and East Khandesh Districts were manifested as minute, water-soaked, translucent, round to angular leaf-spots measuring 1-3 mm. Under severe infection, the spots coalesce forming streaks along the veins. Leaves appear to be more susceptible and drop down with the slightest touch when heavily infected. The pathogen herein named *Xanthomonas martinicola* sp. nov. differs from *Bacterium martyniæ* Elliott in many respects. Its technical description is as follows:

Short rods with rounded ends, single but rarely in pairs, measuring $1{\cdot}3 \times 0{\cdot}6\,\mu$; gram negative; capsulated; non-spore-forming; not acid-fast; motile by polar flagellum; colonies on potato dextrose agar plates circular with entire margin, smooth, glistening, butyrous, 6-12 mm. in 8 days, Baryta yellow (R); growth on potato cylinders copious, flowing, Barium yellow (R); gelatine and starch attacked; casein digested; milk peptonised with curdling; litmus reduced; NH_3 and H_2S from peptone; NO_3 not reduced; no indole; M.R. and V.P. tests negative. In a peptone-free medium, acid without gas from glucose, lactose, xylose, sucrose, mannitol, levulose and glycerol; no growth in salicin; aerobic; thermal death-point about

52° C. Optimum temperature for growth 27-30° C.

Pathogenic to *Martynia diandra*. Found in Nasik and East Khandesh Districts.

3. Leaf-Spot of *Vitis carnosa* Wall.

A new bacterium inciting spots on leaves of *Vitis carnosa* received from Jalgaon differs from others pathogenic to *Vitis* spp. The spots are 1-3 mm., rough to touch, dark in colour and surrounded by halo with raised centre due to bacterial exudate. The technical description of the pathogen herein named *Xanthomonas vitis-carnosæ* sp. nov. is given below:

Short rods with rounded ends, single but rarely in pairs, measuring $1{\cdot}6 \times 0{\cdot}8\,\mu$; gram negative; capsulated; non-spore-forming; not acid-fast; motile by a polar flagellum; colonies on potato dextrose agar plates circular with entire margin, smooth, glistening, butyrous, 5-10 mm. in 8 days, Barium yellow (R); growth on potato cylinders copious, flowing, Baryta yellow (R); gelatine and starch attacked; casein digested; milk peptonised with clearing at the top; litmus reduced; NH_3 and H_2S from peptone; NO_3 not reduced; no indole; M.R. and V.P. tests negative. In a peptone-free medium, acid without gas from glucose, lactose, xylose, sucrose, mannitol, levulose, galactose and glycerol; no growth in salicin; ærobic; thermal death-point about 51° C.; optimum temperature for growth 27-30° C.

Pathogenic to *Vitis carnosa* but not to *V. vinifera*. Found at Jalgaon.

The detailed account will be published elsewhere.

Plant Pathological Lab., College of Agriculture, Poona, *May* 27, 1958.

L. Moniz.
M. K. Patel.

SELECTION OF MURRAH BUFFALOES FOR MILK YIELD ON THE BASIS OF UDDER CONFORMATION

Farmers in India usually select buffaloes for milk yield on the basis of udder conformation. This phenomenon has never been put to any scientific test. We are, however, for the first time reporting here an experiment which gives evidence of the utility of udder conformation for selecting buffaloes for higher milk yield.

Twenty Murrah buffaloes constituted the experimental material, seven in first lactation, eleven in second lactation and two in third lactation. The health of these animals in general was very good. Milk yield of each animal was recorded under supervision.

The animals were scored before the evening milking. The udder score was made by visualizing distention of the udder. Animal with highly distended udder and with prominent milk vein was scored high for udder conformation and least for shrunken udder and with less prominent milk vein. Since the variation amongst animals for udder size did not appear to be very large, only three scores 2, 1, and 0 were given in the descending order of their merits. Each animal was scored thrice by two observers. While scoring each time the observers made no reference to the score given last time. The score used for the final assessment of analysis is the sum of scores of the three readings of both the observers.

Table I
Analysis of variance

Source of variation	d f.	S.S.	M.S.
Between observations ..	2	0·050	0·025
Between observers ..	1	0·008	0·008
Between animals ..	19	52·091	2·742*
Between observers × observations	2	0·417	0·209
Between observers × animals ..	19	4·442	0·234
Between observations × animals	38	7·284	0·165
Between observers × observations × animals	38	6·633	0·174

* Significant at 1% level.

Table I indicates significant differences between animals. These significant differences are of great advantage since selection for milk yield on the basis of udder conformation can be practised. However, the level of scoring was maintained uniformly since no difference between observers could be observed and their repeatability was 0·73 which is highly significant.

Table II
Phenotypic correlation coefficients

Relations	Correlation coefficients
Between udder score × milk produced after score	+ 0·872*
Between udder score × milk produced at the peak of the lactation	+ 0·517*
Between udder score × total yield for entire lactation	+ 0·328

* Significant at 1% level.

Data on milk yield were corrected for stage of lactation. Udder score was correlated with (i) milk produced after scoring, (ii) milk yield at the peak of lactation (4th and 5th months), and (iii) total milk yield for the entire lactation.

Results presented in Table II indicate that udder conformation gives an accurate prediction of the animal's milk yield for that time and relatively less information about the peak of lactation but it gives no information about the animal's milk production during the entire lactation.

Thanks are due to Dr. R. L. Kaushal, Principal, and Joint Director of Research, for his advice and encouragement during the course of this investigation.

College of Veterinary Science and Animal Husbandry-*cum*-Livestock Research Institute, Mhow, M.P., *June* 25, 1958.

G. C. TANEJA.
D. S. BHATNAGER.

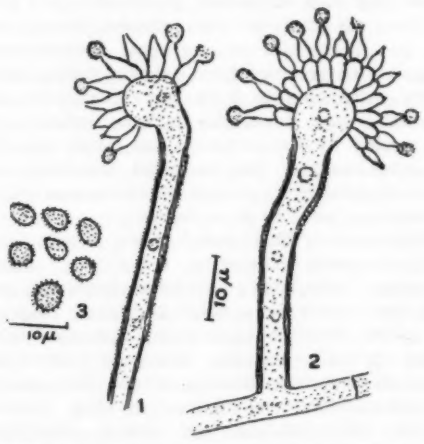
AN ADDITION TO INDIAN ASPERGILLI

MOHANTY (1948) published an account of Indian Aspergilli in which he dealt with twenty-four species. Later on, Chattopadhyay and Dasgupta (1953) added three more species. More recently Saksena and Shetye (1956) have published an account of three other species of *Aspergillus*. This paper adds one more species of *Aspergillus* to the list of Indian Aspergilli already known.

During the course of investigation of soil fungi of grasslands of Banaras, the author has found thirteen species of *Aspergillus*, out of which *A. lutescens* Bainier has been recorded for the first time from India.

The fungus was isolated from soil collected at a depth of 4" from stands of *Dichanthium annulatum* Staf. association having *Cyperus* sp. and herbs like *Croton sparciflorus* Morung., *Corchorus acutangularis* Lamk., *Cassia tora* Linn., *Euphorbia hirta* Linn., *Vernonia cineria* Less., *Crotolaria medicagenia* Lamk., *Digera arvensis* Forsk., *Tephrosia purpurea* Pres., *Amaranthus viridis* Linn. and others. The pH, moisture content and temperature of soil at this depth were 7·2, 15·6% and 88° F. respectively.

Colonies on Czapek's agar rapidly growing and broadly spreading, floccose, margin at first white becoming rusty yellow with conidial formation, finally becoming chestnut brown (Maerz and Paul, 1930; plate 7 E, 10) when conidial areas mature. Reverse of colonies pale yellow. Conidial heads radiate, hemispherical to subglobose, Buckthorn brown (Maerz and Paul, 1930; plate 13 L, 8) to Dresden Brown (Maerz and Paul, 1930; plate 14 K, 8), comparatively small 70-90 μ in diameter when young; conidiophores 9-12 μ in diameter, varying greatly in length, mostly short, arising from substratum or as aerial branches from hyphæ, walls pale yellowish with pitting, sometimes pitting not clear. Vesicles globose to



FIGS. 1-3. *Aspergillus lutescens* Bainier. Figs. 1-2. Conidial heads with single and double series of sterigmata respectively. Fig 3. Conidia.

sub-globose, 18-30 μ in diameter. Sterigmata in one series on smaller heads, upto 14·5-25·0 μ by 4·5-5·4 μ. Sterigmata often in two series on larger heads, primary nearly 14·4-18·0 μ by 4·5-5·4 μ, secondary 9-12 μ by 4·5-5·0 μ. Conidia globose, from 5·4-9·0 μ in diameter if globose, 8·0 × 7·2 μ-9·0 × 7·2 μ, if sub-globose, roughened with tubercles of colour.

The culture of this species is being deposited in the Indian type culture collections of fungi, Indian Agricultural Research Institute, New Delhi, India.

I have great pleasure in expressing my indebtedness to Dr. R. Y. Roy for guidance, and to Prof. R. Misra for facilities.

RAMA SHANKAR DWIVEDI.

Dept. of Botany,
Banaras Hindu University,
Varanasi-5, *June* 27, 1958.

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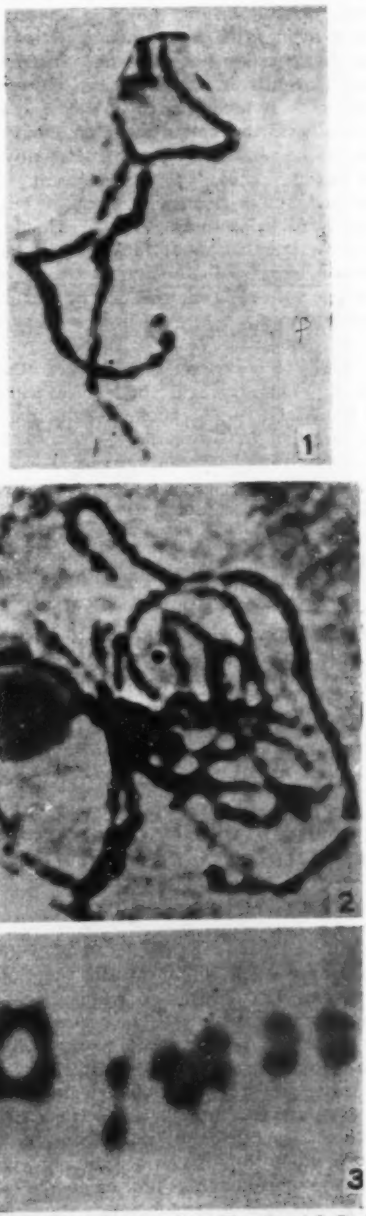
A CASE OF CHROMOSOMAL INTERCHANGE IN PEARL MILLET

KRISHNASWAMY AND RANGASWAMY AYYANGAR (1941)[1] reported chromosomal alterations in three plants of *Pennisetum typhoides* in a population raised from X-rayed seeds. In about 28% of the cells examined by them rings or chains of four chromosomes and in one plant larger rings of six chromosomes were observed. In addition a case of inversion was inferred. In the ring-forming cells unequal distribution of chromosomes was noted by them at anaphase I, and sometimes the movement of the entire ring to one pole was reported. The plants were semi-sterile.

In plants raised from seeds of *Pennisetum* species got from different countries for the study of morphology of pachytene chromosomes, a structural hybrid of Pearl Millet, *Pennisetum typhoides* called *P. glaucum* in America, showing reciprocal translocation was encountered by the writer. The plants showing the chromosomal interchange are commercial hybrids evolved by Dr. Glenn W. Burton at Tifton Georgia, and named as "Gahi 1".

Figs. 1 and 2 represent the cross-shaped configurations at pachytene stage. If a segmental interchange has occurred, one would expect during early meiotic prophase in plants heterozygous for this interchange a cross-shaped synaptic complex made up of two normal and two interchanged chromosomes (McClintock, 1930).[2] Of the chromosomes involved one seems to be that with median centromere and of medium size and the other to be with a sub-median centromere. An analysis of pachytene chromosomes in related materials AKP 3 and AKP 2 (*P. typhoides* local) has shown that the 7 haploid chromosomes can be distinguished on the basis of the total length of the chromosome and the position of the centromeres. On this basis the 7 pairs of pachytene chromosomes could be classed into (i) 2 pairs which are longest in the complement with median centromeres, (ii) 2 pairs with median to sub-median centromeres and smaller than the first 2 pairs of chromosomes, (iii) 2 pairs with sub-median centromeres and of medium size, and (iv) lastly one pair of nucleolar organisers. One of the chromosomes belonging to the second group and one belonging to the third group seem to be involved in segmental interchange here reported.

At diakinesis in 150 cells examined at random 75 cells showed a ring of four chromosomes *plus* five bivalents and 29 cells showed a chain of four *plus* five bivalents. The chiasma frequency in cells having rings or chains and those without rings or chains showed no variation. Of the two types of orientation of the ring at meta-



FIGS. 1–3. Microphotographs. Figs. 1 and 2. Pachytene stages showing the cross-shaped configuration. Fig. 3. Metaphase I showing the open ring. × 2,400.

phase I (McClintock, 1932[3]; Garber, 1955[4]; Burnham, 1956[5]) only the open ring could be seen in a large number of cells (Fig. 3). The zig-zag orientation of the ring could not be located even after a careful examination of a large number of cells. The open ring at metaphase I results in the adjacent segregation at anaphase I and consequently leads to sterility. On this basis the pollen sterility should correspond to the percentage of cells showing ring of four chromosomes. Fifty per cent. of cells examined showed rings of four. The pollen analysis revealed only 40% of sterile pollen, this shows that in about 10% of cells with rings alternate type of disjunction at anaphase I may be expected. Thus on theoretical grounds, 10% of ring-forming cells may have zig-zag orientation at metaphase I.

I wish to express my sincere thanks to Prof. J. Venkateswarlu for helpful suggestions, and to Dr. Glenn W. Burton, Principal Geneticist, Georgia Experimental Station, U.S.A., for the kind supply of seed.

This work was carried out during the tenure of Government of India Research Scholarship.

Dept. of Botany, J. V. PANTULU.
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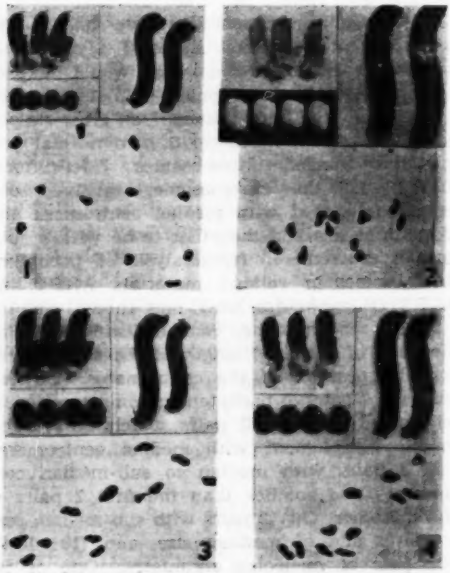
INTERSPECIFIC HYBRIDIZATION BETWEEN *MUCUNA PRURIENS* DC. AND *MUCUNA COCHINCHINENSIS* A. CHEV.

Mucuna Adan, a tropical genus of vigorous leguminous woody climbers, belongs to family Papilionaceæ. Index Kewensis mentions about 30 species in this genus, while Cooke (1903) describes only 4 species as occurring in Bombay State. *M. pruriens* is a hardy twiner, commonly found growing wild in this part of India. Its leaves form an excellent cattle fodder till the plants come into flower. The stiff hair on the pod and the calyx cause considerable irritation when they penetrate human skin. Its seed has considerable use as medicine (Watt, 1891). *Mucuna cochinchinensis* A. Chev. (Syn. *M. nevia* DC.) is a cultivated annual. The plant forms a valuable leguminous fodder all throughout the tropics and its seeds are used as vegetable. This plant is also used for green manure. It appears to be one of the excellent species of the genus from the point of view of food and fodder (Burkill, 1935). According to him, hybridization between the cultivated species of *Mucuna* is possible.

M. pruriens has flowers with dark purple petals and calyx and short pods with bristles, whereas *M. cochinchinensis* has flowers with pale purple petals and calyx. Its pods are long smooth and without any bristles. Crosses were made between these plants in order to introduce hardiness of the wild parent, *i.e.*, *M. pruriens*, in the cultivated parent, *M. cochinchinensis*. Reciprocal crosses were also secured. Both the F_1 hybrids were intermediate between the two parents in petal and calyx colour, pod size and the bristles on the pod. The seeds of *M. pruriens* are brown whereas in *M. cochinchinensis* they are white. In both the F_1s they are of brown colour indicating the dominance of brown colour. The seeds are intermediate in the size when compared with the parents.



FIGS. 1–4. Flowers, pods, seeds and chromosome at Metaphase I ($n=11$), ×1,500 in (1) *Mucuna pruriens*, (2) *Mucuna cochinchinensis*, (3) F_1 *M. pruriens* × *M. cochinchinensis* and (4) F_1 *M. cochinchinensis* × *M. pruriens*.

Flower-buds from the parents and the two F_1s were fixed in acetic alcohol 3 : 1 and stained with proprionocarmine. The chromosome

number of *M. pruriens* is $2n = 22$, which agrees with the one determined by Fram Leliveld as reported by Darlington and Wylie (1955). The chromosome number in *M. cochinchinensis* is also $2n = 22$. Meiosis in the parents is normal and Figs. 1-4 show the chromosomes at Metaphase I in parents and the hybrids as well as some of the morphological characters. Study of inheritance of morphological characters is in progress.

My grateful thanks are due to Dr. M. C. Desai, Economic Botanist, Department of Agriculture, Bombay State, Poona, for the help and guidance in these investigations. I am thankful to Shri A. S. Jadhav for the photographs.

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ERGOT OF *BAJRI* (*PENNISETUM TYPHOIDES*) IN BOMBAY STATE

IN an earlier note[1] the ergot of *bajri* [*Pennisetum typhoides* (Burm.) Stapf and Hubbard] was recorded in South Satara District of Bombay State and its pathogenicity to *bajri* was proved by inoculation with *Sphacelial* stage (Fig. 1). The present note deals with the physiology of the pathogen and its identity.

In artificial culture the fungus is very fastidious in its nutrition, requiring 6% cane sugar and 0·5% proteose peptone. It grows well only on a few culture media such as Kirchoff's original and modified medium (solid as well as liquid), Sabouraud's medium, modified Czapek's medium and on steamed flowering heads of *bajri*. It does not elaborate many enzymes and is incapable of utilising amino acids singly as source of carbon and nitrogen. Conidia, produced on a few media only such as Kirchoff's, germinate readily at 25-27° C. The thermal death-point of the mycelium and of conidia lies around 55° C.

The mature sclerotia contain 0·42% *w/w* of the total alkaloids of ergot calculated as ergotoxin.

The fungus is pathogenic to *bajri* only and did not infect any of the other species of *Pennisetum* tested. All available varieties and strains of *bajri* from Bombay State proved highly susceptible to ergot infection and hence

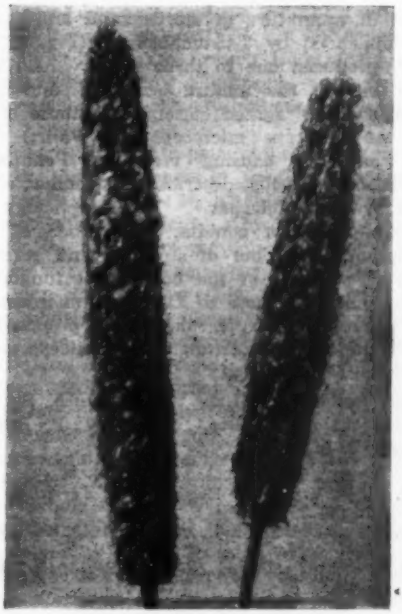

FIG. 1. *Sphacelial* stage.

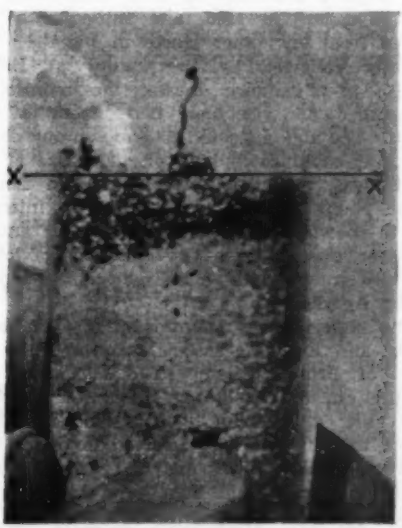

FIG. 2. Germinating sclerotium, × nat. size.

scope for breeding resistant varieties seems uncertain.

A few sclerotia germinated after 35 days when kept in a mixture of sterile sand and soil as recommended by Thirumalachar[2] (Fig. 2) and each produced one to three stipes. Asci were produced in the mature stromata and their measurements agreed closely with those of the asci of *Claviceps microcephala* (Wallr.) Tul., the pathogen causing ergot of *Pennisetum hohenackeri* Hochst described by Thomas *et al.*[3] and by Thirumalachar.[2] The morphology and measurements of conidia, their mode of germination, the colour of stromata and germination of sclerotia of the *bajri* ergot fungus are also similar to those of *Claviceps microcephala* (Wallr.) Tul. It is, therefore, proposed to refer the *bajri* ergot fungus to *Claviceps microcephala* (Wallr.) Tul.

Plant Pathological Lab., College of Agriculture, Poona, *July* 9, 1958.

P. A. Shinde.
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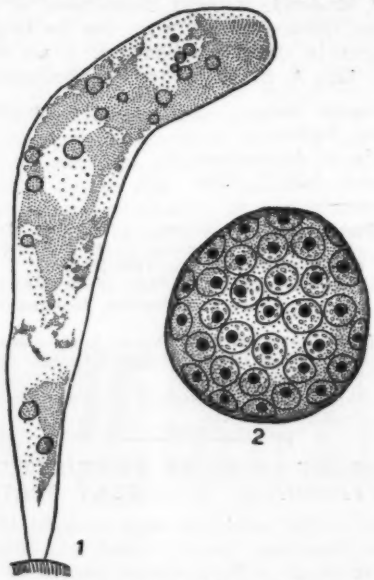
ASEXUAL REPRODUCTION IN *CHARACIOSIPHON RIVULARIS* IYENGAR

The alga *Characiosiphon* first established by Prof. Iyengar[3] in 1936, and subsequently reported from few other places in India[1,2,6] was recently collected by the author at Indore (M.P.) in abundance during the months of September and October 1957, from a city drain. The alga appeared to grow on any object which it could catch hold of. The size of the thalli was recorded upto 1·1 cm. in length. Some young thalli were particularly interesting in showing lobed condition but the author, however, could not get any indication of lobing in fully grown thalli in his material as reported by Agarkar.[1]

The material was microtomed for a detailed study and the observations confirmed the results of Prof. Iyengar.[3] The alga was also cultured in the laboratory in water obtained from the drain with a little Knops solution added to it, in which it survived for more than a week or so. Zoospores and gametes were easily obtained, as the alga, kept even in rainwater, produced these swarmers the next day at about 10 to 12 o'clock in the laboratory. Nothing strikingly different from what Prof. Iyengar[5] has recorded was observed except a peculiar phenomenon of asexual reproduction by cyst formation which is described below. These cysts, however, were also observed in the material collected from natural habitat.

Some of the old thalli, showing signs of degeneration, transformed a major part of their protoplast into numerous spherical bodies (Figs. 1, 3) which varied from 67 to 169 μ in diameter. These consisted of several discrete



Figs. 1 and 2. *Characiosiphon rivularis* Iyengar. Fig. 1. Entire thallus showing disintegrating protoplast and rounded protocœnocysts, ×15. Fig. 2. Single protocœnocyst, ×150.

uninucleate .protoplasts surrounded by a newly secreted wall forming a spherical "protocœnocyte" (Fig. 2). These were freed from the thallus by the gelatinization of the parent wall and the protocœnocytic bodies, after liberation, attached themselves to the slides kept in the culture dishes; probably by secreting some adhesive substance and started germination immediately without any resting period. The subsequent germination and growth stages of these bodies were exactly like those of the zoospores except that the growth in this case started initially as a protocœnocyte and not as a single cell.

Formation of cœnocyst is known in the genus *Protosiphon*,[4] where the protoplast breaks up into numerous multinucleate masses and each

gets surrounded by a new wall. *Characiosiphon rivularis* exhibits a similar mode of cyst formation with the modification that here the cyst is formed as a protocœnocyte from the very beginning. Therefore, it is suggested that the

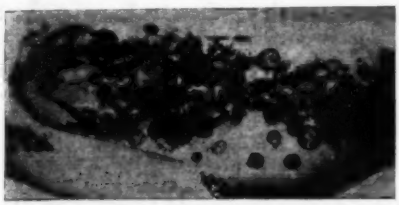


FIG. 3. Photomicrograph of *Characiosiphon rivularis* Iyengar, showing a part of the thallus with rounded protocœnocysts, ×38.

cyst, in case of *Characiosiphon*, may be designated as a 'protocœnocyst'. However, it would be unsafe to draw any affinity between *Characiosiphon* and *Protosiphon* only on the basis of similarity in cyst formation, as the two algæ differ markedly from each other in various other important characters.

The author is thankful to Dr. W. V. Bhagwat, Principal, and Prof. D. W. Kshirsagar, Head of the Department, for facilities and encouragement. Grateful thanks are also due to Prof. M. O. P. Iyengar for going through the manuscript and for his valuable suggestions.

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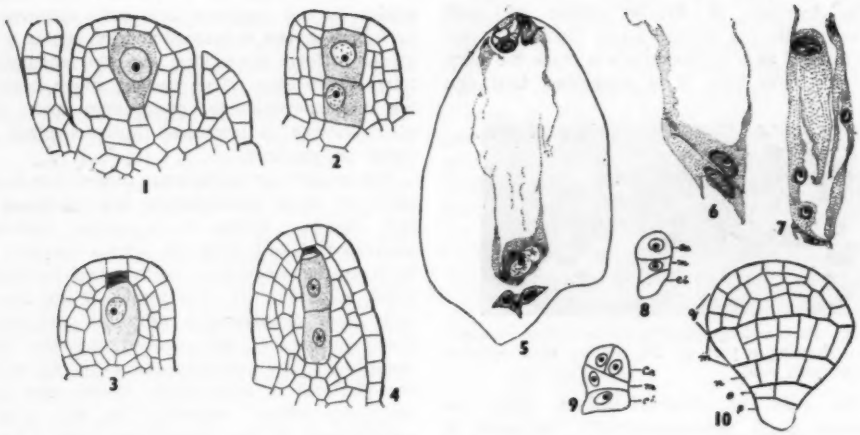
MORPHOLOGY OF THE OVULE OF *ZEPHYRANTHES CITRINA* BAKER

Of the 60 species of *Zephyranthes*[1] only three have been investigated,[2–5] and in no case is there much information on the development of the embryo. According to Pace[2] the division of the primary endosperm nucleus of *Z. texana*, an apomictic species, is followed by a wall which soon disappears. In *Z. andersonii* the endosperm is Helobial; the thin membrane separating the chalazal and the micropylar chambers was clear in early stages while it could not be seen subsequently.[3] Mendoza[4] states that in *Z. rosea* the synergids are devoid of a filiform apparatus and that the antipodal nuclei do not organize into cells although Stenar[5] had earlier described the synergids with an apical filiform apparatus and the antipodals as fairly large cells. The present study deals with the megasporogenesis, endosperm and embryo of *Z. citrina*, a perennial bulbous plant cultivated in gardens.

The numerous anatropous ovules are borne in pairs on axile placentæ in the trilocular inferior ovary. There is a single hypodermal archesporial cell (Fig. 1) which directly functions as the megaspore mother-cell forming two dyad cells (Fig. 2). The upper of the two dyad cells soon disintegrates (Fig. 3) and only the lower undergoes the second meiotic division resulting in two megaspores (Fig. 4) of which the chalazal is functional. Three free nuclear divisions follow resulting in an 8-nucleate embryo-sac of the Polygonum type. The two polar nuclei begin to fuse about the time the second male nucleus reaches them in the chalazal region. The synergids are hooked but no large vacuoles are seen in them. A filiform apparatus is present in the apical part while the nucleus is placed basally. The antipodal cells persist in a hypertrophied condition during the post-fertilisation stages for a considerable time. The micropyle is formed by the inner integument only. Fertilisation takes place approximately five hours after pollination. A point of interest is the presence of a clear space around the male nucleus that fuses with the egg while such a space is not seen around the second male nucleus that fuses with the two polar nuclei to form the primary endosperm nucleus (Fig. 5).

The endosperm is of the Helobial type. The primary endosperm nucleus divides earlier than the fertilised egg and results in the formation of a smaller chalazal and a much larger micropylar chamber (Fig. 6). Free nuclear divisions take place in both the chambers but the divisions are much more numerous in the micropylar chamber. Ultimately there are about 16 nuclei in the chalazal chamber. During early stages the nuclei in the micropylar chamber are distributed in the peripheral cytoplasm. At places some of the nuclei seem to divide much more rapidly in the micropylar chamber and the daughter-nuclei so formed fuse and divide again resulting in polyploid nuclei (Fig. 7). Later, cell-wall formation takes place in micropylar chamber while the antipodal cells and the coenocytic chalazal chamber disintegrate. In the final stages some of the endosperm cells contain



FIGS. 1–10

FIG. 1. L.s. ovule showing the archesporial cell, × 250. Fig. 2. L.s. nucellus showing the dyad cells, × 250. Fig. 3. Same showing the disintegration of the upper dyad cell, × 250. Fig. 4. Same showing the two megaspores formed from the lower dyad cell, × 250. Fig. 5. Embryo-sac showing syngamy and triple fusion (drawn from three sections), × 60. Fig. 6. Endosperm showing the micropylar and chalazal chambers with one nucleus in each, × 160. Fig. 7. Micropylar chamber of the endosperm showing triploid nuclei and polyploid nucleus, × 160. Figs. 8–10. Stages in the development of embryo, × 160.

polyploid nuclei while others contain triploid nuclei.

The embryo conforms to the Asterad type of Johansen[6] (Figs. 8, 9, 10). The vascular strand that supplies the ovule can be traced into the base of the outer integument on the side opposite to the funicle.

Grateful thanks are due to Professor P. Maheshwari for scrutinising some of the preparations and for valuable suggestions. Thanks are also due to the Director, Royal Botanic Gardens, Kew, for identifying the plant and to the Ministry of Education and Scientific Research, Government of India, for a grant-in-aid.

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INDIAN HOUSE SPARROW AS AN ENEMY OF THE DESERT LOCUST

HUSAIN AND BHALLA (1931) stated that the Indian house sparrow, *Passer domesticus*, had not been seen preying upon the adults of the desert locust, *Schistocerca gregaria* (Forsk.), in Ambala District (Punjab), nor had the locust been found in the stomach of this bird. The observations made by the author in Bikaner District from 1954 to 1956 have, on the other hand, shown that this bird actively preys upon both adults and hoppers of the desert locust. During the monsoon months, groups of sparrows may be seen roosting on the bushes in the desert area where large number of desert locust adults may also be met with. The sparrows generally catch locusts at the pronotum with their beaks and then strike them on the ground till they are killed before devouring. Sometimes they catch them in their claws and put them in their beaks and kill. Wings are not eaten.

The sparrows may often be seen in flocks specially during post-monsoon and early winter season. Their zigzag flights near the ground must disturb the locust adults which are probably devoured while they fly about.

The sparrow was seen preying largely on the early stage hoppers and feeding its young ones

on them while other enemy birds of the desert locust prefer to feed on advanced stage hoppers.

It was also observed preying upon the escapes of adults from the field cages during rearing in 1954, 1955 and 1957 at Bikaner.

Locust Warning Officer, Churu (Rajasthan), July 21, 1958. CHARAN SINGH.

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PRELIMINARY OBSERVATIONS ON THE SYSTEMIC ACTION OF THREE ORGANIC PHOSPHATES ON THE RED COTTON BUG [*DYSDERCUS CINGULATUS* (FABR.), HEMIPTERA: PYRRHOCORIDAE]

INTRODUCTION of chemical substances into the sap of plants by vascular injection has been commonly practised in the past for controlling pests and diseases. But in recent years, many workers have claimed successful control of some insect pests with systemic insecticides. Systemic insecticides are classified as those chemicals which are absorbed and translocated through roots or leaves to other parts of the plants, exerting toxic effect on the insects feeding on them.

The studies on the systemic action of the organic phosphates (*Systox*, *Pestox* and *Diazinon*) were carried out against the "Red cotton bug". To initiate this investigation, the *Bhindi* plants were potted in earthen pots. When the plants were fifteen days old, the trial was undertaken. The solutions of each chemical at three levels of concentration (0·05%, 0·025% and 0·0125%) were added to the soil as irrigation water. Soon after the treatment, each treated pot was covered with a layer of dry soil for providing a compact uniform coating against evaporation of chemical-fumes. After an interval of twenty-four hours, the treated earthen pots with plants were put inside wire cages. Ten adult bugs were confined in each cage for studying the systemic reaction of the chemicals. Each treatment including control was replicated thrice. Records of mortality of bugs under different treatments were maintained for eight days.

The percentage of mortality of the adult bugs under the treatments of Systox, Pestox and Diazinon were 52·2, 36·7 and 21·1 respectively at 0·05% concentration as against 13·3, 13·3 and 3·3 mortality at 0·0125% concentration. Systox and Pestox treatment gave identical response at 0·0125% concentration. The maximum kill of the "Red cotton bugs" under different treatments were recorded on the third day of the experiment. None of the organic phosphates included in the trial seems to exhibit any phytotoxic reaction on the plants. Curiously enough, an increased fruiting was observed on treated plants as compared to those which were untreated ones.

The findings of this paper confirm the observation of Ivy and his associates (1950) that Systox has more pronounced systemic action than other organic phosphates tried against the cotton pests. Banerjee and Basu (1955) reported that Tetrax (an organic phosphate compound) when absorbed and translocated through the roots of the plants was found to render the plants toxic to the "Red cotton bug". The increased fruiting as observed on the treated *Bhindi* plants indicated that the organic phosphate used in the experiment might have been converted into available phosphates and they were in turn utilized by the plant for increased yield. This may also account for a rapid decomposition of the toxicities of the organic phosphate compounds. Such reaction in plants are clearly demonstrated by Fukuto and his associates (1955). The chemical Pestox seems to have a definite systemic reaction. However, it needs further confirmation.

The authors wish to express their gratitude to Dr. R. H. Richharia, Principal, for providing necessary facilities in the Post-Graduate Laboratory for carrying out the investigation.

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A NEW CUTWORM PEST OF POTATO IN RAJASTHAN

THE cutworms, *Agrotis interacta* Wlk., were unusually abundant in the potato fields in Udaipur during March 1958. Lighter infestations were present on regular cultivated plots but on newly ploughed lands populations were very high ranging from 5 to 11 cutworms per square foot. The habits and nature of damage of this insect were quite different from those

of the other cutworms reported as pests of potato in India.[1,2] This is the first record of the occurrence of this species as a pest.

The full-grown larvæ are brownish grey, plumpy and measure nearly 2" in length, and have the usual habit of curling the body tightly when disturbed. They are exclusively subterranean species and move entirely underground and cut off the plant 1-2" below the surface resulting in the death of the plant. Most of the damage, however, occurs on the tubers buried upto 3" deep in the ridges. They eat on the tubers by chewing cavities and are found resting inside them (Fig. 1). A number of

FIG. 1. The resting cutworms inside the damaged potato tubers.

square foot sample ridges containing 6-10 larvæ were carefully examined and observed to have 30-35% of the tubers damaged. Such losses in yield present a real economic problem to the farmers.

The larva transforms into a pupa by making a rough earthen cocoon in the field under protective cover of any nature. The pupal period lasts about 10 days under conditions prevalent in late March and April. The adults, after emergence, tend to rest on or around herbaceous plants commonly found near the fields.

In a small plot BHC and aldrin were tried each at 2 lb. actual toxicant per acre by incorporating the dusts in the soil and earthing up the ridges again. None of these applications gave any satisfactory protection to the tubers. This method was not attempted further because of the lack of knowledge of the possible residue hazards with such chemicals and the danger of imparting off-flavour or undesirable odour to the potatoes which were reaching maturity. The post-harvest larval count in one of the infested fields under observation averaged as high as 10 cutworms per square foot.

The author is indebted to Dr. A. Rathore, Principal, for providing facilities and encouragement for this work. Thanks are also due to Head of the Division of Entomology, Indian Agriculture Research Institute, New Delhi, for identification of the insect.

Dept. of Agri. B. K. SRIVASTAVA.
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SPERMATOGONIAL CHROMOSOMES OF TWO LIZARDS, *HEMIDACTYLUS BROOKI* GREY AND *VARANUS MONITOR* LINN.

THE diploid karyotype of *Hemidactylus brooki* (Fig. 1) shows 40 elements, comprising 24 macro- and 16 micro-chromosomes. The macrochromosomes consist of 4 V-shaped and 20 rod-shaped chromosomes. The arms of the V-shaped chromosomes are of unequal lengths and are sub-medially attached to the spindle fibres. The rod-shaped chromosomes appear to be acrocentric in nature and are all of intergrading sizes. The points of their spindle fibre attachment are generally directed towards the centre of the spindle. The micro-chromosome part of the karyotype consists of 16 dot-shaped bodies of different sizes. Their extreme smallness makes it difficult to observe clearly the mode of spindle fibre attachment but, in all probability, they are telomitic in nature. They always occupy a central position in the spindle and are surrounded by the macro-chromosomes, which constitute a peripheral ring round them.

The chromosome complement of the male karyotype in *H. brooki* is :

4 V's + 20 R's + 16 D's = 40

FIG. 1. Polar view of Spermatogonial Metaphase in *Hemidactylus brooki*, × 4,000 (approx.).

FIG. 2. Polar view of Spermatogonial Metaphase in *Varanus monitor*, × 4,000 (approx.).

In a polar view of the spermatogonial metaphase (Fig. 2) in *Varanus monitor*, 40 elements are always counted, and like the spermatogonial chromosomes of *H. brooki*, the components of this chromosome complex can also be distinguished into macro- and micro-chromosomes. A morphological analysis of the various elements shows that the macro-chromosomes, which are 16 in number, consist of 6 V-shaped and 10 rod-shaped chromosomes. The 4 bigger V-shaped chromosomes are sub-median, while the remaining 2, median in spindle fibre attachment. The rod-shaped chromosomes are all acrocentric in nature. The micro-chromosomes, which consist of dot-shaped chromosomes, generally remain dispersed inside the peripheral ring formed by the macro-chromosomes. Most of these dot-shaped chromosomes do not show much size difference and appear to be terminal in spindle fibre attachment. The chromosome complement of the male karyotype in *Varanus monitor* is :

6 V's + 10 R's + 24 D's = 40

Karyotypes of 7 species of lacertilians, belonging to the family Geckonidæ, have been studied so far. Table I shows the various details.

The chromosome complement of *H. brooki* appears to be quite interesting as it differs in one way or other from all those hitherto described.

From the family Varanidæ, chromosomes of a single species, *Varanus gouldi*, have been studied so far (Matthey[5,7]). The diploid chromosome complex in this species also shows 40 elements but the number of V-shaped metacentric chromosomes is 8 as compared to 6 seen in *V. monitor*. Moreover, the rod-shaped chromosomes show an increase in number by two elements in *V. monitor*. Consequently, the fundamental chromosome number also differs—it is 46 in *V. monitor* and 48 in *V. gouldi*.

The author wishes to express his indebtedness to Prof. M. D. L. Srivastava under whose guidance the present investigations were carried out.

Dept. of Zoology, A. N. BHATNAGAR.
Univ. of Allahabad,
Allahabad, *May* 29, 1958.

TABLE I

Species	Sex	By whom worked out	Chromosome formula	Fundamental chromosome no.
Hemidactylus flaviviridis ..	♂	Asana and Mahabale[1]	46 R's	46
Hemidactylus bowrengi ..	♂♀	Nakamura[2]	46 R's	46
Hemidactylus frenatus ..	♂♀	Makino and Momma[3]	46 R's	46
Gekko japonicus ..	♂♀	Nakamura[2]	4 V's+34 R's	42
Gekko japonicus ..	♂♀	Su-Hsuen[4]	40 R's	40
Tarentola mauretanica ..	♂♀	Matthey[5,7]	42 R's	42
Gymnodactylus milliusi ..	♂♀	Matthey[6,7]	38 R's	38
Gehyla variegata ogasawarasima	♀	Makino and Momma[3]	63 R's	63

V = Metacentric, includes V- and J-shaped. R = Acrocentric includes rod- and dot-shaped.

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REVIEWS

Technology and the Academics. By Sir Eric Ashby. (Macmillan & Co.), 1958. Pp. vii + 118. Price 15 *sh.*

Universities preserve through centuries a recognisable individuality and identity of pattern. This survival of identity is a sign that they have adapted themselves to successive cultural environments. In this little book the author gives a masterly exposition of how British and Scottish universities reacted, slowly but surely, to the intellectual outlook of the people following the scientific revolution that started in England and spread through the continent.

It is legitimate to speak of a scientific revolution, for although there has been no age since the time of Aristotle without its scientists, there was, contained within two or three generations in the seventeenth century, a unique flowering of genius—Kepler, Galileo, Harvey, Boyle, Newton, Lavoisier—which reorientated the thought of Western Man.

The continental countries quickly reacted to this new scientific outlook. By 1800 the scientific spirit was firmly established in France and had permeated its education. From France it crossed the Rhine to Germany where it combined with the *Wissenschaft* of the early German humanists, and by the middle of the 19th century the Universities of Germany had adapted themselves wonderfully to the scientific age and led the world in research.

The full impact of the sientific revolution came back to British universities from the Laboratories of Germany. It emancipated Oxford and Cambridge from the constraints of dogmatic knowledge, and universities became centres of scientific research. This awakening coincided in time with pressure from big centres of population to have their own colleges for higher education and within the decade 1871 to 1881 seven Civic Universities were established.

With the growing necessity to maintain industrial supremacy in the midst of keen competition from the continental countries, the government stepped in to give State support for higher technological education and today 18 out of 22 British Universities include technology in their curricula. Yet the split personality in universities continues—the antithesis between imparting a liberal, 'gentlemanly' education and teaching tendentious knowledge. Technology which is 'unashamedly tendentious' is tolerated but not assimilated. Until this ambiguity is resolved the Universities will not have adapted themselves to one of the major consequences of the scientific revolution.

The author puts in a strong plea for the inclusion of technology in a liberal education so that technology may become the core of a new twentieth-century humanism.

The book which is attractively got up, is sure to have a wide appeal to educationists, administrators and those interested in educational planning in the present age.

A. S. G.

Synchronous Motors and Condensers. By D. D. Stephen. (Chapman & Hall), 1958. Pp. ix + 500. Price 60 *sh.* net.

A large percentage of electrical power consumed by industry is used to drive induction motors in view of the fact that they are the cheapest form of A.C. motors in the smaller sizes. Next in importance are the synchronous motors which have been used for large motor drives as the advantages of high efficiency, operation at a fixed speed or the possibility of running at unity or a leading power factor have frequently made these more economic propositions. Synchronous motors are now being increasingly used for a wide variety of industrial purposes such as steel rolling mills, cement grinding mills, mixers, crushers, grinders, pumps, fans, for driving D.C. generators, etc. With a growing recognition of the use of controlled kvar for transmission of power, synchronous condensers have an important role to play as sources of controlled kvar.

The book under review is intended as introduction to the characteristics of synchronous motors and condensers and discusses the problems encountered when selecting the most suitable type of equipment for particular application. It is one of a series of *Advanced Engineering Text-Books* written by the technical staff of the B. T. H. Co.

The book is divided into twelve chapters. Chapter I is of an introductory nature and deals in a general way with the choice of type of motor. Chapters II and IV deal respectively with the steady state and transient characteristics of synchronous motors. Chapter III is de-

voted to power factor correction and excitation control. In Chapters V, VI and VII, starting characteristics, starting methods and starting schemes are discussed in great detail. Prevention of machine failure and protective devices are dealt with in the succeeding two Chapters. Chapters X and XI are devoted to a consideration of application problems, selection of motor and control equipment.

Power System Engineers would find Chapter XII to be of special interest to them as it deals exclusively with the operating characteristics and application problems of synchronous condensers.

In determining the most desirable rating for a motor it is necessary to consider a number of factors such as (*a*) factors determined mainly by the load characteristics, (*b*) factors determining the class of insulation and allowable temperature rise and (*c*) factors affecting the cost and size of a motor. It is possible to design any type of motor for any application but the size and cost may have to be increased appreciably. The choice of motor and starting method should be based on economic grounds in conjunction with technical desirability. Some of the most usual applications and their special requirements have been clearly and fully discussed. The book would, therefore, be of great interest to application or plant engineers responsible for the choice and installation of electric motors for industrial purposes. Students of electrical engineering would also find the book, a useful reference. I have no doubt in my mind that the book is worthy of a place in all technical libraries.

H. N. RAMACHANDRA RAO.

How Television Works. By W. A. Holm. (Philips Technical Library), 1958. Pp. 318. Price Rs. 18.94.

Excellent books on television dealing with the subject in a rigorous fashion are available, and these demand a fairly high standard of knowledge of radio engineering and higher mathematics on the part of the reader. The book under review, however, presents the subject in a very palatable form to the interested reader who has had no more than a nodding acquaintance with electronics.

The book consists of six parts : (I) Principles of Picture Transmission, (II) Electronic Scanning, (III) The Video Signal, (IV) Oscillations : Electronic Tubes : Pulses, (V) The Complete Television Signal, and (VI) The Television Receiver. The heart of the television equipment is the pick-up tube which converts the picture of the scene projected on to its sensitive element into electrical pulses. The tube in current use known as the image orthicon, which bases itself for its function on photo-sensitivity, is the culmination of years of research in evolving suitable materials and novel design procedure. The story of the tube is a sequel to the experience gained in the construction of its forerunners. The electronic scanning methods employed in these tubes, and the function of the different elements are explained in a very objective fashion.

The signal from a television transmitter designated as the video signal is a combination of signals of different kinds, each one carrying an important message, to ensure that the receiver works in absolute synchronism with the transmitter. Part 3 deals with this aspect.

In Parts 4 and 5 problems of generating oscillations and pulses are dealt with, and also the modulation and radiation of electromagnetic waves. The sixth part describes the complete television receiver.

The book begins with an introduction to the principles underlying television and the difficulties of the earlier pioneers in the field.

Starting from first principles, all salient features of a modern television receiver are explained. The treatment adopted is non-mathematical and the physical principles involved in picture transmission and reception are delightfully presented with numerous illustrative diagrams.

The book is written in clear lucid style and anyone who wishes to have a correct and good appreciation of this subject would, in the opinion of the reviewer, profit greatly by reading this book.

A. J.

Evolution by Natural Selection. By Darwin and Wallace. (Cambridge University Press), 1958. Pp. 279. Price 25 *sh.* net.

This volume is published to commemorate the centenary of Darwin-Wallace Theory of Evolution by Natural Selection. There is an illuminating foreword by Sir Gavin de Beer in which he shows that the unprecedented advance of biological knowledge during the hundred years that have elapsed since the publication of the theory "does nothing but confirm it (the theory), even if new formulations are required as knowledge increases". The foreword is followed by an introduction by Sir Francis Darwin written in 1909, tracing the development of the evolutionary idea and the theory of Natural Selection in Darwin's mind. When he started

on his voyage on the *Beagle* his opinions were on the side of immutability of species. By 1837 he became a convinced evolutionist though he wrote the first sketch of the theory only in 1842. In Darwin's own words "In June 1842 I first allowed myself the satisfaction of writing a very brief abstract of my theory in pencil of 35 pages; and this was enlarged during the summer of 1844 into one of 230 pages". The sketch of 1842 and the essay of 1844 occupy pages 41 to 88 and 91 to 254 of the book. They are the forerunners of the "Origin of Species" and like it are an elaborate argument to show that the mutability of species under selection in nature is the only possible inference from the observed facts of organic nature. The last 22 pages of the book are devoted to the Darwin-Wallace papers of 1858 through which the Theory of Evolution by Natural Selection came to be known to the world.

The essay of 1844 is shorter and more pointed and so more readable than the "Origin". But it is less known than the "Origin" and hardly available, so that the reprinting of it in this book is valuable. Wallace's essay makes refreshing reading. Though eclipsed by Darwin in the eyes of the general public due credit should go to him for his independent discovery of the principle of Evolution by Natural Selection.

From a close reading of the original papers contained in this book one gets the impression that the only serious flaw in the theory as propounded by Darwin relates to his ideas of heredity. He believed in the inheritance of the so-called acquired characters and 'blending' inheritance both of which have been superseded by Mendelian particulate inheritance. It is only in this part of the theory that reformulation becomes necessary in the light of modern knowledge. In fact, as pointed out in the foreword, even in 1844 Darwin had correct knowledge of the variations of the first and second generations of hybrid progeny. But at that stage of biological knowledge he did not realize the significance of it as Mendel did 21 years later.

In making the original papers of Darwin and Wallace available this attractively got up Centenary Commemorative volume serves a real need.

P. K. MENON.

Recent Progress in Hormone Research. Edited by G. Pincus. (Academic Press, Inc., Publishers, New York), 1957. Pp. vi + 646. Price $ 12.00.

Recent Progress in Hormone Research, Vol. 13, represents a collection of papers and discussions at the Thirteenth Annual Laurentian Hormone Conference held in Canada in 1956. The subject-matter has been grouped under five sections covering rather wide areas of inquiry in the field of endocrinology.

The volume opens with the section on 'Neuro-Endocrine Relationship'. This large problem has been diversely attacked by the Bethesda group, Greer and Richter. The serotonin problem has been reviewed and brought up-to-date by Udenfriend and his colleagues. They have repeatedly emphasized that in spite of the attention and investigative efforts bestowed on this substance, its physiologic role in the body still awaits elucidation. By a series of elegant experiments, Anderson *et al.* have been able to demonstrate profound metabolic alterations and disturbance in hypothalmicohypophysial mechanism of release of ACTH and TSH in the dog, after transection of the spinal cord or the midbrain. They have postulated the existence of a mesencephalic hypothalmicohypophyseal excitatory system. Greer has presented meticulous data on the hypothalmic control of pituitary TSH, GTH and ACTH activity. He has aptly pointed out the possible vital role of the reciprocal 'push-pull' mechanism between the circulating level of the target gland hormone and the production of appropriate pituitary trophic factor in neuroendocrine control. He believes that part of this mechanism operates *directly* at the pituitary level and part through a depression of the appropriate hypothalmic or other nervous centres. The reviewer is in full agreement with these views. It may not be out of place here to mention that there is a tendency among some enthusiastic neurophysiologists to ignore such possibilities and regard the hypothalmus as the *sole* custodian of the secretory potentialities of the hypophysis. Greer's views find support in Richter's studies on 'Hormones and Rhythms'.

The fascinating problem of the hormone transport in circulation has been the subject-matter of Section II. Robbins and Rall have dealt with the binding of thyroxine with the specific serum globulin (TBP) in euthyroid, hypothyroid and hyperthyroid patients. Sandberg *et al.* have adduced valuable data relative to the binding of various steroid hormones (estrogens, progesterone, testosterone and glucocorticoids) and their conjugates to plasma proteins. The steroids are probably transferred in such bound form in the body although the binding is of a weak and reversible nature. The liver does not seem to play an important role in this process

in spite of the fact that it may form strongly bound steroid-protein complexes. An interesting finding by these authors is the role played by the erythrocytes in the transport of some steroids in the body.

In the section on aspects of reproduction, Shelesnyak has presented extensive studies on the mechanism of ova-transplantation in rat. He believes that histamine is involved in decidual cell transformations and nidation in this species. He has marshalled very impressive evidence in support of his view which, if substantiated and extended to other species, will be an outstanding contribution in mammalian reproductive physiology. Rock *et al.*'s paper on synthetic progestogens is a detailed account of their work published previously (*Science*, 124, 891, 1956). The views expressed by one of the eminent discussants (Hartman) of this paper about the hazards involved in the steady use of these compounds by the normal human female merit careful consideration. Davis and Plotz have presented clinical data based on sound endocrinologic rationale regarding the beneficial use of progesterone in patients who have had habitual abortions. They have also provided a schema of biogenesis and metabolism of progesterone. Junkman has traced the evolution of long-acting estrogens, androgens and progestogens and has discussed their probable mode of action.

The section on hormone chemistry and metabolism is prefaced by Mirsky's comprehensive studies on the relationship of the so-called "Insulinase" and "Insulin-inhibitors" to diabetes mellitus. The "Insulinase" approach to diabetes problem has certainly illumined a path but has not yet brought us to the goal. The same may be said about glucagon, the progress of research on which has been admirably reviewed by Foa and his colleagues.

The book concludes with two apparently unrelated but basically interlinked papers on 'Hormones and Stress'. In the first of these, Moore has presented extensive data on endocrine changes after anæsthesia, surgery and unanæsthetized trauma of different magnitude in man. Gray and Ramsay have reviewed clinical and experimental evidence for an adrenal-gastric relationship in man, integrating the gastric and peptic glands into the general endocrine mechanisms.

The present volume of *Recent Progress in Hormone Research* like its predecessors, is a worthy publication and research workers in the ever-expanding field of endocrinology would look forward to the regular appearance of other volumes in this 'Recent Progress' series.

B. MUKERJI.

Introduction to Enzymology. Editor : Alan H. Mehler. (Academic Press, Inc., New York ; India : Asia Publishing House, Bombay-1), 1957. Pp. 425. Price $ 10.80.

Enzymes play the same important role in biochemistry in the present decade which vitamins and hormones did in the last two, and so quite a few books on enzymes have appeared recently. Most of the treatises published on enzymology till now, however, have been presented, on the whole, from a physico-chemical view-point—description of general properties of enzymes, purification, kinetic studies, etc., followed by a study of the principal groups of enzymes classified according to the kind of chemical transformation they catalyze.

This method of presentation has the defect of not indicating clearly the enzymatic interrelations in intermediary metabolism. It is to remedy this defect that A. H. Mehler has published a book based on the course in enzyme chemistry taught by him at the National Institute of Arthritis and Metabolic Diseases. The portion reserved for the general characteristics of enzymes has been reduced to a strict minimum necessary to understand the succeeding chapters. This reviewer, however, feels that a general approach to the isolation and purification of enzymes could have been profitably included in the introduction.

The author deals in a series of chapters the principal metabolic transformations ; he describes also for each of these the essential properties of the multiple enzymes catalyzing the transformations one after the other.

This method of presentation is more empirical than that adopted in the text-books of enzymology treated—from a physico-chemical view-point, but it appears to succeed in its aim. In fact, the grouping in the same chapter of enzymes taking part successively and simultaneously clears up for us the complexity of the metabolic processes. The author has lifted the artificial barriers of biology and has tried to show us the dynamics of biological reactions at a cellular level.

In a series of chapters the author describes : Hydrolysis of Peptides and proteins ; Fermentation and Oxidation of Major Metabolic Fuels (Carbohydrates and Fatty Acids); Biological Oxidation ; Sugar and Sugar derivatives ; Polynucleotides and their Components ;

Amino Acids; Acids and Acid Derivatives; and, Organization of Structure and Function.

The book surpasses the ordinary class of introductory manuals of enzymology; it is also more than just an abstract of enzymological work dealing with intermediary metabolism. The books in this latter domain are so many and so varied that it is impossible to have an over-all idea of enzymology.

In a field where advance in knowledgde is taking place practically every day, it is not easy to keep track of all the current literature on the subject included in the book. Nevertheless, it may be pertinent to point out two omissions which might have been avoided. Under "Purine Biosynthesis", both in figure 26 on page 265 and in the text on page 266 a tentative intermediate has been postulated between 5-aminoamidazole ribotide and aminoimidazole carboxamide ribotide, *i.e.*, 5-amino 4-imidazole N-succinyl carboxamide ribotide. Not only this intermediate but also its immediate precursor—5-aminoimidazole carboxylic acid rebotide was isolated and identified by Lukens and Buchanan (*J. Am. Chem. Soc.*, 79, 1511, 1957), thus filling the gap in our knowledge of purine biosynthesis some six months before the book was apparently sent to the press. The other omission occurs on page 30, where the statement is made that "gluconate is oxidized to 2-ketogluconate by incompletely described bacterial enzymes". Actually the isolation and purification of gluconic dehydrogenase were reported a few years back (*Biochim. et Biophys. acta*, 17, 122, 1955).

In spite of these minor criticisms, *Introduction to Enzymology* is an excellent text, not only to students of enzymology, but also for students of general biochemistry.

T. RAMAKRISHNAN.

Genetics and Plant Breeding in South Asia—(An International Symposium sponsored by the Indian Society of Genetics and Plant Breeding and UNESCO, South Asia Science Corporation Office—Delhi), Jan. 21-25, 1957. *Indian Journal of Genetics and Plant Breeding*, 17, No. 2, Special Symposium Number.

In this Symposium inaugurated by Dr. B. N. Uppal, some of India's leading workers in the subject, as well as the foreign visitors, Dr. G. L. Stebbins of California University, Dr. O. H. Frankel of the Darwin Institute of Plant Industry, CSIRO, Canberra, Australia, and Dr. A. Gustafsson of the Forest Research Institute, Sweden, have taken part. Of the 24 papers discussed, half the number relates to crop breeding, and the rest to other aspects, *viz.*, genetics, cytogenetics, physiology, and plant introduction.

The Breeding Section covers a wide range of field crops—cereals, fibres, tubers, tobacco, sugarcane and nine different types of oilseeds. As expected, emphasis is directed to problems and their solutions peculiar to South Asian regions and to an assessment of Indian achievements in the field. As is well known, in modern plant breeding methods of hybrid production and the intervarietal transfer of genes have been developed to a high degree of efficiency; but the more complex phenomena of cytogenetics associated with induced polyploidy, induced mutation, and gene transfer across interspecific barriers are also opening up newer vistas of investigation. This widening horizon of the plant breeder is excellently revealed by Dr. Stebbins in his critical contribution to this Symposium.

Closely connected with breeding programmes is Plant Introduction, and two important aspects of this are discussed by Dr. Frankel and Prof. L. S. S. Kumar.

As in other spheres, any programme of breeding resistance to disease and insect pests requires the well-planned and co-operative effort of team workers—breeder, geneticist, pathologist, entomologist, biometrician, technologist. The importance of this need for co-ordination is indicated by Dr. A. B. Joshi in the Genetics Section. Dr. P. Maheshwari's contribution entitled "Hormones in Reproduction" deserves special attention for its excellent condensation of the important aspects of this new field of inquiry. The exciting possibilities of the new technique of "test-tube" fruit production and the biological action of the recently discovered kinins and gibberellins cannot fail to stimulate the inquiring research mind and lead it along fresh avenues of exploration in the promising field of Experimental Plant Embryology.

The two papers on mutation research evoke an appeal like that of new discovery being noteworthy for the hopeful notes they strike. Dr. M. S. Swaminathan reveals the prospect of the geneticist inducing useful mutation in polyploids. This is encouraging, but perhaps not so exciting as the new possibilities indicated recently by Swedish mutation workers. As Dr. Gustafsson points out, there is now sufficient experimental proof to indicate that the mutation processes, once considered sporadic and unpredictable, may in the near future be controlled and directed by artificial means.

The Indian Journal of Genetics and Plant Breeding is to be congratulated for producing

this volume of high technical excellence. It contains a wealth of ideas and information not only indispensable to workers in these and associated fields, but also to advanced students of Botany and Agriculture in our Universities.

H. D. NORONHA.

Chemical Aspects of Ecology in Relation to Agriculture. By Hubert Martin. (Science Service Laboratory, University of London, Ontario), 1957. Pp. 96. Price $ 3.00.

A review of certain basic problems concerning host parasite relationship, as also available information on the biologically active chemicals present in the crop environment and involved in the intricate phenomenon of parasitism, is presented. The book is a clear and stimulating survey of present knowledge of the antibiosis and symbiosis which are of fundamental importance in crop production. It provides clear indication as to the gaps in our knowledge and the lines on which further information must be sought for. The control of insect pests through production of resistant varieties of crop plants is, no doubt, attractive but it appears there is considerable scope for exploitation of the toxic or deterrent substances present in the plants for use in plant protection. In this direction, some outstanding cases have been quoted, such as the resistance of *Solanum demissum* to the larvæ of Colorado beetle which has been ascribed to "Tomatin" content. It is further indicated that basis of gall formation or other malformations as a reaction of plants to insect attack require fuller investigation.

The parasitism may be established by fungi on account of the toxins secreted by them in advance of actual infection or as a reaction of host and pathogen so that it is difficult to generalise this until more information on the mode of action of fungi is available on a variety of phytopathogenic fungi. The potentialities of biological control in plant diseases have been reviewed and information on the successful use of some of those so far employed has been clearly brought out. This aspect, it is indicated, requires further research with a view to its practical utilization on a much wider scale than hitherto practised.

The author has done great service to those interested in the fundamental study of exploitation of natural resources in Plant Protection by providing direct evidence available on the subject under one cover.

R. S. VASUDEVA.

Books Received

Biophysical Chemistry, Vol. I. (*Thermodynamics, Electrostatics and the Biological Significance of the Properties of Matter.* By J. T. Edsall and J. Wyman. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1958. Pp. xv + 699. Price $ 14.00.

Dry-cleaning Technology and Theory. By A. R. Martin and G. P. Fulton. (Interscience Publishers, Inc., New York), 1958. Pp. viii + 269. Price $ 6.00.

British Medical Bulletin—Causation of Cancer, Vol. 14, No. 2. (Medical Department, The British Council, 65, Davies Street, London W. 1), 1958. Pp. 73-196. Price 25 *sh.*

Discovery Reports, Vol. XXIX. (*The Distribution of the Cœtognatha of the Southern Ocean.*) By P. M. David. (Cambridge University Press, London), 1958. Pp. 199-228 Price 18 *sh.* 6 d.

Applied Mathematics and Mechanics, Vol. III. (*Mathematical Theory of Compressible Fluid Flow.*) By R. von Mises. Completed by H. Geiringer, G. S. S. Ludford. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1958. Pp. xiii + 514. Price $ 15.00.

Some Catalytic Gas Reactions of Industrial Importance. By J. C. Ghosh, S. K. Bhattacharya and M. V. C. Sastry. (The Director, Oriental Institute, Baroda.) Pp. xi + 355. Price Rs. 13.50.

Sound Pulses—Cambridge Monographs on Mechanics and Applied Mathematics. By F. G. Friedlander. (Cambridge University Press, London, N.W. 1), 1958. Pp. xi + 202. Price 40 *sh.*

Advanced Engineering Text-Books—Conformal Transformations in Electrical Engineering. By W. J. Gibbs. (Chapman & Hall, London, W.C. 2; India: Asia Publishing House, Bombay-1), 1958. Pp. viii + 219. Price 45 *sh.*

Pre-Stressed Concrete—Theory and Design. By R. E. Evans and E. W. Bennett. (Chapman & Hall, London, W.C. 2; India: Asia Publishing House, Bombay-1), 1958. Pp. xv + 294. Price 60 *sh.*

Advances in Petroleum Chemistry and Refining, Vol. I. Edited by K. A. Kobe and J. J. McKetta Jr. (Interscience Publishers, Inc., New York-1), 1958. Pp. xv + 641. Price $ 13.50.

Indigenous Drugs of India. Second Edition. By R. N. Chopra, I. C. Chopra, K. L. Handa and L. D. Kapur. (U. N. Dhur & Sons, 15, Bankim Chatterjee Road, Calcutta-12.) Pp. xxxii + 816. Price not given.

SCIENCE NOTES AND NEWS

Detection of Mustard Oil Used as Adulterant

Shri S. N. Mitra and Shri P. N. Sengupta of the Central Food Laboratory, Calcutta, report a simple method of detecting mustard oil used as an adulterant in other edible oils. The method consists in reducing the volatile essential oil of mustard, which contains sulphur, by nascent hydrogen and the H_2S evolved is detected by lead acetate paper. To about 10 ml. of the oil in a boiling tube are added 10-15 ml. of dilute hydrochloric acid (1:1) and a few large pieces of pure zinc metal. A strip of moist lead acetate paper, pinned to the cork, is hung inside the tube. If mustard oil is present, with the slow evolution of hydrogen over a period of one to two hours, depending on the quantity of the adulterant present, the lead acetate paper will blacken gradually.

Naphthalene as Deterrents for Snakes

Shri B. K. Sharma (Vigyan Mandir Officer, Sundernagar, H.P.) reports that naphthalene balls act as deterrents for snakes. The belief that onion, garlic or ginger keeps away snakes has been found to be untrue.

Observations made on three snakes in a cage showed that they were not affected at all by onions, garlic or ginger kept inside the cage, whereas with naphthalene balls they became sluggish after 24 hours and died successively one after the other within 3 days.

Velocity of Light

Results of tests by scientists at Columbia University in September were reported as confirming again—in their suggestion that the velocity of light is constant—Einstein's Special Theory on Relativity.

In the Columbia experiment, it is said, the theory that light should move at a constant velocity regardless of the motion of observers was tested with a precision never attained before, a precision made possible by the use of an electronic device, the "maser" (see *Curr. Sci.*, 27, p. 117).

"The maser has a cavity into which is directed a beam of ammonia particles accelerated to high speed. The molecules vibrate in the cavity and give off radio waves. Measurement of the frequency of the generated radio waves provides a precise measurement of the passage of time when the masers are used as atomic clocks."

The research group mounted two masers—with their ammonia beams pointing in opposite directions—on an instrument panel that could be rotated through 360°. The masers were pointed east and west and the frequency of the radio waves generated by the speeding ammonia particles was determined. Then the equipment was roated 180° and a new determination was made.

In the experiment, frequencies of radio waves generated when the ammonia beams were aimed with the earth's motion were compared with frequencies of waves generated when the beams were aimed in the opposite direction. The comparison was made to an accuracy of one part in a million millions.

The experiment was repeated many times. Calculations had shown that if the earth's motion round the sun altered the observed light velocity, this should disclose a difference of 20 cycles a second in the frequencies between the maser ammonia beams pointed east and west. "Actually, a difference of about one cycle a second was found throughout the day. But this, the experimenters said, was caused by the earth's magnetic field and the magnetic influence of other electrical equipment in the (university's) Watson Laboratory. Outside the magnetic effects no variation greater than a fiftieth of a cycle a second was observed."—*Science Newsletter*, 4487.

Volcanic Eruption on Moon

The Soviet astronomer Dr. Nikolai Kozyrev has registered a volcanic eruption on the Moon.

Observing the lunar surface with a 50" reflector of the Crimea Astrophysical Observatory, he took a surprising snapshot of the central peak of the "Alphonse" crater at about 4 hours Moscow Time on November 3. The crater had a reddish hue greatly weakened by violet rays. For 30 minutes after 6 hours of the same day, the brightness of the peak suddenly doubled. Bright lines of carbon and its components appeared in the peak's spectrum. There was one particularly bright line resembling those usually produced by molecular carbon.

Further photographs showed the crater in its natural state.

Dr. Kozyrev has taken 20 photographs of the "Alphonse" crater's spectrum during the past three weeks.

The present observations are of great scientific interest and are likely to upset the existing hypothesis about the origin of the main peculiarities of the lunar surface which ascribes them to the impact of meteorites striking the Moon. This volcanic eruption shows that the processes which are responsible for the characteristic features of the lunar landscape are similar to those on the earth for the formation of the mountain relief.

The Nangal Heavy Water Plant

The Nangal Heavy Water Plant, whose construction has been undertaken by the Government of India, is expected to produce 14 metric tons of heavy water per year and 70,000 metric tons of nitrogen as nitro-limestone.

Investigations of the feasibility of producing heavy water in India began early in 1954. At that time, information was available on only two processes—electrolysis and water distillation. Because it was felt that water distillation was a very expensive process, electrolysis of water was adopted as the method of primary enrichment with another, then undetermined, method for final concentration.

In response to an invitation, detailed reports were received from three firms in August 1956. Although all the processes suggested took advantage of the concentration obtained in the electrolyzers, different processes for the final D_2O enrichment were recommended, namely, ammonia distillation, catalytic exchange followed by water distillation, and hydrogen distillation.

On the basis of the data supplied by these firms in their reports, technical and economic evaluation of the three processes were made. As a result of this study it was concluded that although the catalytic exchange process was a well-known process and had a background of 10 years of industrial scale operation, the hydrogen distillation process treating a reduced amount of enriched hydrogen would be economically more attractive and technically more suitable for conditions in India. A cost analysis for a typical hydrogen distillation plant gives the total cost of production, including capital charges as $ 28 (Rs. 140) per lb. of D_2O.

Compared to the above the Savannah River plant of the U.S. A.E.C., constructed in 1951-52 at a cost of $ 164 million, gives the cost of production as $ 30 per lb. of D_2O.

In this plant, heavy water is extracted from natural water using a combination of three processes:

(1) Dual temperature exchange between H_2S and water. The product from this step contains about 15% D_2O.

(2) Vacuum distillation—the product contains about 90% D_2O.

(3) Electrolysis—the end-product contains 99·75%. The production rate is 1 million lb. D_2O per year.—*Report to Geneva Atoms for Peace Conference.*

Electronic Device for Assessing Uranium Ore

An electronic device, known as an ore grade discriminator, is an unusual piece of equipment at Australia's uranium mine at Mary Kathleen, in Queensland. Located between the mine and the acid treatment plant, the device assists in the bulk sorting of the uranium ore supplies.

The device is housed in an archway type of framework 16 ft. high and consists of six Geiger tubes. Trucks containing ore from the mine pass under the arch on their way to the treatment plant. Gamma rays from the radium content of the ore react on the Geiger tubes which feed a "count" into a junction box, and in turn to a ratemeter. In a matter of only two seconds the ratemeter converts the total gamma ray count of the truck load into an equivalent uranium oxide percentage. The truck is then directed to the appropriate stockpile of ore, depending on its grade. The device is operated by only one man.

It was invented by Mr. R. Sterrett, a Tasmanian geophysicist, in conjunction with Mary Kathleen Uranium Ltd.'s chief geologist, Mr. F. Hughes.—*Commonwealth of Australia News and Information Service.*

Radar with a Memory

A radar screen can now be made to show the whole path of the aeroplane or ship it has been observing over the preceding 20 minutes or less. It is made to do this by arranging that the stored images shall respond only to infrared light, and this, in turn, is achieved by the development of a special phosphor coating for the cathode-ray tube.

With the new phosphor the tube can be given two coatings the one nearest the observer being the storage phosphor and the backing layer consisting of the normal coating capable of converting electron energy into blue, violet or ultra-violet light. The backing layer thus reproduces the immediate image; the layer

in the forefront yields its "remembered" images on demand from infra-red light.

This infra-red illumination also serves to erase the stored image so that the screen is clear for fresh impressions immediately after use has been made of it. The system thus is essentially one of controlled afterglow.

Hitherto, something of the same service of relating a sequence of images could be obtained by using a long-persistence phosphor which left a prolonged afterglow on the tube. This had the disadvantage of cluttering up the screen and making it unready to display new images. Also if the glow was required to persist for several minutes, permanent damage to the phosphor was likely.

With the help of the new phosphor and the infra-red light, the duration of the glow is determined by the operator. The light comes from a series of small-filament lamps fitted with filters which pass infra-red wavelengths and exclude most of the others. They are switched on and off at need.

The new type of phosphor, known as Y, has been developed by the Electronic Department of Ferranti Ltd.—*Science Newsletter*, 4577.

Germanium Thermometers for Near Absolute Zero Temperatures

Low-temperature research has highlighted the need for a reliable and sensitive thermometer, not requiring continual calibration, in the range of temperature near to the absolute zero. Kunzler, Geballe and Hull of Bell Telephone Laboratories have developed a Germanium resistance thermometer to satisfy the rigorous needs of low temperature calorimetry. Germanium can be doped with arsenic to produce a high and constant temperature coefficient at teperatures near to the boiling point of helium. The thermometer consists of a single crystal of arsenic-doped germanium, $0{\cdot}025 \times 0{\cdot}02 \times 0{\cdot}210$ inches, with attached current and potential leads and supported in a strain-free manner in a platinum-glass enclosure filled with a small amount of helium. A current of a fraction of a mico-ampere is passed through the crystal and the potential drop is measured. A typical thermometer had a resistance of 1 ohm at room temperature, 14 ohms at 10° K. and 216 ohms at 2° K. Both the temperature coefficient and the resistance vary with the amount of doping and thus thermometers of different characteristics can be made. Once calibrated the thermometer is accurate to 10^{-4} of a degree at the boiling point of helium (4·2° K.), even after repeated cycling from room temperature to 1° K.

Preserving Hard Wood with Oxy-welding

An unusual method for preserving hardwood poles, electrical transmission poles, and other timber structures contracting the ground and which is in use in Australia, employs oxy-welding for scouring and charring the timber. The technique prevents decay due to fungi termites, and other wood-destroying agents.

The high temperature flame produces a charred layer on the timber, and is hard, fine-textured and of comparatively strong adherence. It is of the right porosity to allow absorption, and retention of creosote preservative, which is applied with a pressure spray while the pole is still warm.—*Commonwealth of Australia News and Information Service.*

Microwave Chemistry

Much research is today being carried out on synthetic polymer materials in which the basic framework contains elements other than carbon, for example silicon, boron, phosphorus, or aluminimum. So far, the only commercial products of this type are the silicones (built up of silicon-oxygen-silicon chains) and the valuable characterstics of silicons, such as thermal stability and water repellency, have encouraged work on other "inorganic" polymers in the hope that new materials with useful properties will be obtained.

It is against the background that interest attaches to the discovery of a new technique for preparing diboron tetrachloride, B_2Cl_4. This compound is a possible starting point for preparing polymers with both boron and carbon in the basic framework (for example, boron-carbon-carbon-boron chains), but until now it has been obtained only with difficulty.

J. W. Frazer and R. T. Holzmann of the Radiation Laboratory of the University of Califonia have found (*Journal of the American Chemical Society*, 80, 2907) that if ordinary boron chloride (BCl_3) is passed in gaseous form through a resonant cavity fed with microwave energy of about 12 cm. wavelength it becomes partially converted to diboron tetrachloride and chlorine.

No mechanism is suggested for the reaction, but it would seem probable that some kind of gas discharge may occur in the cavity in regions of high field strength; otherwise it is difficult to understand how the microwave energy could effect reaction. Frazer and Holzmann intend to investigate the new technique further and suggest that it might be applicable to other reactions.—*Science Newsletter*, 4576.

Germanium as a Catalyst

The special electrical properties of germanium, which make it so useful in transistors, also enable it to act as a catalyst to accelerate certain chemical processes. It is prepared for this role by subjecting it to an electric discharge; apparently a number of chemically active electrons are thus concentrated on the surface. As a result weak chemical bonds can be formed with other materials, enabling the germanium to collect the reacting materials on its surface and release them as the chemical changes are completed. According to Dr. Y. L. Sandler, who has experimented with germanium at the Westinghouse Research Laboratory, its catalytic activity is as high as is found in the best known catalysts.—*Science Newsletter*, 4577.

Electron-Exchange Resins—Organic Intermediates

Two methods of preparation are reported by NCL: (*a*) by reaction of quinones containing labile halogen atoms with alkali metal derivatives of polyhydroxy compounds, *e.g.*, reaction of sodium cellulose or sodium polyvinyl alcohol, with tetrachloroquinone or 2 : 5-dichloromethylhydroquinone diacetate; or (*b*) by impregnation of hydrophilic materials with water-insoluble quinones. A wide range of quinones of varying redox potential can be used for this purpose, it is stated.

Applications for electron-exchange resins are: removal of O_2 from boiler water or other solutions; preparation of hydrogen peroxide, in the reduced form as polymerisation inhibitors for vinyl resins and in the oxidised form as polymerisation catalysts for vinyl monomers; as anti-stain agents in photographic emulsions; as antioxidants, *e.g.*, prevention of peroxides in ethers; potentially useful as prophylactics for ionising radiations which are not rapidly excreted from the body (not a generaal application); either member of the couples I^-/I_2, $Fe(CN)_6^{4-}/Fe(CN)_6^{3-}$; Fe^{2+}/Fe^{3+}; Br^-/Br_2 can be oxidised or reduced depending on the state of the resin.

Potential applications suggested are: very selective oxidation or reduction, without contamination, of certain components of a mixture; continuous flow oxidation or reduction of organic or inorganic compounds in solution; and study of unusual or unstable valency states of certain metals.—*Chemical Age*.

Nitro-Paraffins as Substitute for Petrol

Prof. Ernest Starkman, Associate Professor of Aeronautical Engineering at the University of California, has announced the results of initial tests with certain compounds, known as nitro-paraffins, made by mixing methane, propane, butane, and other petroleum products with nitric acids, the use of which, it is claimed, could double the power output of motor car and aircraft engines.

These compounds are relatively expensive, but the resultant fuel could be economical if produced in large quantities. Development of such a fuel could mean that engines using it would be less than half the size and weight of existing engines, but just as powerful.

Whether the nitro-paraffins are explosive is a matter of opinion among experts, but in Dr. Starkman's view they are not more dangerous than ordinary petrol. One problem still to be solved is that of pre-ignition, which occurs when an overheated engine causes premature explosion of the compressed fuel and air mixture. However, Dr. Starkman holds that present-day engines could probably be modified to use the new compounds without experiencing this trouble. The nitroparaffins might be specially useful in diesel engines where pre-ignition is an advantage. The main use of the new fuels in ordinary car engines would probably be as secondary agents to provide sudden spurts of power.—*Science Newsletter*, 4578.

Radioactive Sterilization of Insect Pests

In the past decade new synthetic insecticides have achieved great success in the control and eradication of insect-borne disease, but already their powers are seriously threatened by the emergence of many resistant strains. This intensifies the interest in an entirely new method of attacking insects by liberating large numbers of radioactively sterile individuals. The method depends on the well-known sensitivity of reproductive tissues to radiation. Doses of about 5,000 *r* (ten times the dose lethal to most mammals) can be given to certain insects in the pupal stage without greatly curtailing their lives; but the resulting adults are generally sterile. The females of many insects allow only a single mating, and if this has been with a sterile male the act is sufficient to prevent reproduction. To eradicate a pest, then, it is necessary to liberate sufficient numbers of sterile males to compete successfully with normal wild ones. That this is sometimes feasible has been shown by American workers who have exterminated the "screw worm" fly (which breeds in wounds and sores of animals) from the island of Curacao which has an area

of 170 square miles (440 sq. km.). The flies were reared in vast numbers, sterilized in a cobalt-60 irradiator, and released at the rate of about 400 males per square mile (150 per sq. km.) weekly for about 20 weeks.—*British Medical Journal*, Sept. 20, 1958.

Radioactive Contamination of Food Crops

Radioactive contamination of food crops by Strontium-90 can be reduced by adding lime to the soil, according to Dr. E. B. Fowler of the University of California. Strontium-90 is chemically similar to calcium, one of the chief ingredients of bone. If taken into the body, it concentrates in the bone structures and may cause tumors. Since milk also contains calcium, poisoning could result from the milk of cows fed on contaminated pastures.

Dr. Fowler said that plants grown on soil high in calcium contain less strontium than those grown in low calcium soil. He and his research team noted that when the soil contained as much as one-half to one pound calcium per cubic foot of soil, the plant's uptake of Strontium-90 decreased sharply. They also found that some plants such as lettuce and lucerne seemed to prefer calcium to strontium. Grass, on the other hand, concentrated strontium as it grew.

Dr. Fowler said that if radioactive contamination ever becomes critical, man may be forced to eat food plants with metabolism similar to those of lettuce or lucerne.—*SASLO Newsletter*, 277.

Why Liquids Flow

There has never been any wholly satisfactory explanation of the structure of liquids. Obviously the molecules must all be conforming to some recognisable pattern that gives liquids a unique identity of their own and sets them apart from solids on the one hand and gases on the other. But no one has yet discovered what that pattern might be.

Prof. J. D. Bernal has now put forward a completely new theory in which he claims to have finally identified the missing pattern, the key to what makes a liquid a liquid. Liquids get their unique character from the fact that the molecules in them are neither rigidly dragooned, as they are in a solid, nor completely divorced from their neighbours, as they are in a gas.

The molecules in a solid always adopt formal, barrack-square patterns that are repeated over and over again. In a gas they move at random and make contact only when they accidentally collide. By contrast, the molecules in a liquid are in direct contact with each other, with uneven forces pushing and pulling the molecules from every direction. According to Prof. Bernal they do indeed form a pattern, but it is an irregular, patch-work quilt design that never repeats itself.

Liquid structure is based, he thinks, on a pentagon while solids form three-, four-, and six-sided structures. A pentagon is one shape that it is almost impossible to build into a regular pattern, and this is probably the underlying reason why liquids flow.—*Science Newsletter*, London, No. 388.

Insdoc Report, 1957-58

The Indian National Scientific Documentation Centre which was established in 1952 by the Government of India with the technical assistance of UNESCO, provides a complete range of documentation services. During the past six years there has been a steady increase in the activities of the Centre.

During the period under report the Centre has complied with a total of 6,202 requests for documentation services out of 6,994 requests made. As compared to the previous year, the documentation services completed during the year show an increase of 15·2 per cent.

Award of Research Degree

The University of Cambridge has awarded the Sc.D. Degree in Zoology to Dr. Vishwa Nath, Professor and Head of the Department of Zoology, Panjab University, Hoshiarpur.

The Karnatak University has awarded the Ph.D. Degree in Physics to Shri N. Sreedhara Murthy for his thesis, "Structure of Diatomic Molecules—Study of Electronic Transition Moment Variation in Bands of BeO".

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